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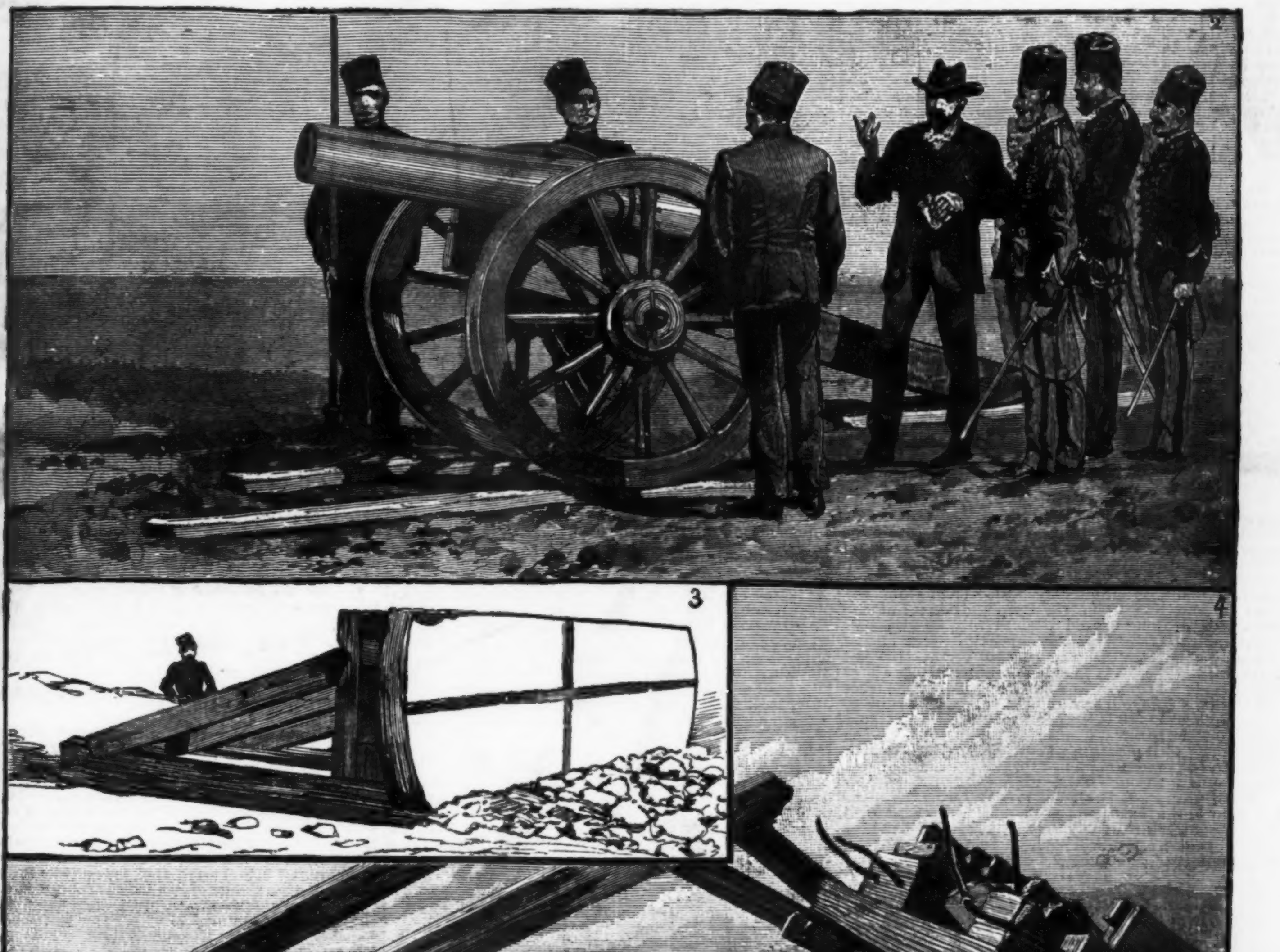
TRIAL OF NITRO-GELATINE SHELLS.

An important series of experiments with artillery discharging nitro-glycerine or nitro-gelatine shells took place about a month ago, under the direction of the war department of the Turkish government, at Agha Deresai, opposite Tchansk Kaleh, on the shores of the Dardanelles. The invention of Mr. F. H. A. Snyder, of New York, a system of throwing high explosives from ordinary guns, was put to the trial at Washington, with a range of about one mile across the river Potomac, and with satisfactory results. The trial of this invention in Turkey seems to have been not less successful. The piece of field artillery employed was a breech-loading rifled howitzer, of 15 centimeters diameter. The target, erected at a distance of 200 meters, was composed of twelve steel plates, each an inch thick, welded together, backed with oaken beams 12 in. by 14 in. thick; it was 4 ft. 6 in. high, 14 ft. 6 in. wide, and weighed altogether over 20 tons, including the massive frame of supporting beams in the rear. A single dynamite shell, exploding in this target, completely destroyed it, overthrowing it and knocking it to pieces. Ten shells were discharged from the same howitzer, which was not injured in the least degree. Mr. Snyder affirms that his shells can be used with guns of any kind, long or short, smooth-bore or rifled. The shell was charged with 10 lb. of Mr. Snyder's explosive, consisting of 94 per cent. nitro-glycerine and 6 per cent. of a compound of collodion, gun-cotton, camphor, and ether. This is said to be much less liable to dangerous accidents than either ordinary dynamite or gun-cotton, as it will not explode from simple contact with fire. It explodes by mere percussion against a hard and solid body, such as the armor plating of a war ship, and would do so even without a percussion capsule. Premature explosion before leaving the gun seems to be prevented. The experiments were personally superintended by General Asif Pasha, the inspector-general of fortifications, who has reported on them to the Turkish minister of war. Photographs of the target and of the howitzer, the officers and artillerymen, were taken on the spot. We understand that the proportion of nitro-glycerine in ordinary dynamite is not above 75 per cent., and that it is much less powerful, and more liable to accidents, than Mr. Snyder's "nitro gelatine." The French army has been making experiments with "melanite" shells, and the Germans with "roburite."—*Illustrated London News.*



2. Breech-loading rifled field howitzer, inspected by General Asif Pasha and his staff. 3. Target composed of twelve 1 inch steel plates, with 14 inches of oaken beams at the back. 4. The target destroyed by a single shell exploding in it.

TURKISH ARTILLERY EXPERIMENTS WITH DYNAMITE SHELLS AT CONSTANTINOPLE.

At the mouth of the Congo there is a remarkable submarine valley. Just at the mouth of the river it is 1,452 feet deep, and it can be distinctly traced for a hundred miles out to sea.

NEW FORMULA FOR THE FLOW OF WATER.

At a meeting of the Society of Engineers, held at Westminster Town Hall, a paper was read on "A New Formula for the Flow of Water in Pipes and Open Channels," by Mr. Edgar C. Thrupp. The author said that, having worked out, by means of graphic diagrams, a formula for the flow of water in pipes, based on a large number of experiments by M. Darcy and others, with some by himself, he was induced to try how far experiments on the flow of water in open channels (such as those by Darcy and Bazin, and by Major Cunningham) would be amenable to the same mode of treatment. The results were not only satisfactory, but unexpectedly threw light upon some points in the question of the flow in pipes which had before been difficult to explain. He had thus been enabled to obtain a general formula, applicable both to pipes and open channels, and taking into account the effects on velocity of the varying relations between hydraulic depth and roughness of surface, in a manner that had not hitherto been done. After describing the experiments of Professor Osborne Reynolds, which brought out the curious fact of a "critical velocity" at which eddies come in, for a limited range of velocities, after which an even flow again takes place, the author described the apparatus he had himself used, and showed

the graphic results of experiments, which he had also reduced to tabular forms. He then gave Reynolds' formula, and Hagen's, of which latter his own was a modification, the changes introduced having for their object to express the effects of various degrees and kinds of roughness in the surfaces flowed over, with varying hydraulic depths. Hagen's formula, as proposed to be modified, is:

$$v = \frac{R^{x + y\sqrt{\frac{z-R}{R}}}}{c\sqrt[n]{S}}$$

In this formula the constants are: For wrought iron pipes, $n = 1·80$, $c = 0·004787$, $x = 0·65$, $y = 0·018$, and $z = 0·07$. For riveted sheet iron pipes, $n = 1·825$, $c = 0·005674$, and $x = 0·677$. For an open channel of pure cement, semicircular (4·1 ft. diameter), $n = 1·74$, $c = 0·004$, and $x = 0·67$. For an open channel of pure cement of rectangular form (5·94 ft. wide), $n = 195$, $c = 0·006429$, and $x = 0·61$; and for open channels of "earth, no vegetation," etc., $n = 2$, $c = 0·015356$, and $x = 0·72$. Mr. Thrupp concluded by justifying the effort to make a more accurate formula, by comparing the results of experiments with the results obtained by calculation.

THE TRANSCASPIAN RAILWAY.

THE construction of railways in Central Asia is certainly one of the greatest events of our epoch. We have already shown the immense development that the Russian government has been able to give its works. The construction of the Transcaspian Railway, particularly, is certainly called upon to take a place in the history of railroading. It has been carried out with a rapidity that leaves far behind it anything of the kind that has hitherto been done in Europe, and probably even in the United States. It is necessary to observe, moreover, that this line, which was constructed at the rate of about 300 miles a month, is laid through deserts that are absolutely destitute of communications and supplies, and in which the Russian colonists have many a time been arrested in former expeditions.

We may recall, for example, the expedition that was made in 1879 against the oasis of Akhal Teke, and which came to grief before Gheok Tepe, the Russians, for want of water and provisions, having been obliged to beat a disastrous retreat. Yet Gheok Tepe, which is but a small citadel of argillaceous earth, destitute of artillery, is situated at 380 versts only from the Caspian Sea. It is now conquered by the railway, of which it forms one of the stations. The line, moreover, runs much deeper into the Turcoman deserts, which it is to cross from one end to the other. After leaving the Akhal Teke oasis, it traverses that of Atek, washed by the Techend, which forms the upper course of the Heriroud, which irrigates Herat. Then it reaches the fertile oasis of Merv, irrigated by the Mourgab, and this celebrated city, which was so long reputed inaccessible, and which was after a manner the symbol of the independence of the Turcoman desert, is connected in turn by continual intercourse with the Caspian Sea and the entire Russian empire.

From Merv, situated at a distance of 769 versts from the sea, the line, thus reaching nearly 480 miles, runs through sandy deserts, almost entirely destitute of water, to Tchardjoui, a city of about 30,000 inhabitants situated upon the river Amou Daria and forming the frontier of Bokhara. This city, which now forms the terminal point, is situated at 1,065 versts from the head of the line upon the Caspian Sea; but the line will before long extend beyond this, and we may count upon the tracks soon reaching the capital city of Bokhara, at a total distance of 1,107 versts. Beyond Bokhara, the direction line has been selected up to Samarcande. It enters Russian Turkestan at the frontier city of Kata Gourgan at 1,292 versts, and runs to Samarcande at 1,350 versts. A variant of this, extending from Merv to Samarcande, and passing through the frontier city of Bourdalik, was studied by the Russian engineers, but was abandoned for the present line now being laid out through Tchardjoui.

From Ouzoun Ada (which at present forms the starting point of the line upon the Caspian Sea), as far as to Samarcande, the road will have sixty stations, whose mean distance apart will be from 20 to 30 versts. A large number of these stations will be located in absolutely desert places, often entirely deprived of water. In fact, stretches of 96 miles without water are met with, and a supply can be secured only through bringing it by cars.

The construction of this 1,080 mile road, more than half of which is already finished, through dry deserts, presents a special interest, and we have thought it well to give a few details upon the subject, borrowed, like the rest of this article, from information gathered *in situ* by Mr. Edgar Boulangier, who has recently visited the works. The first section of the line, begun in 1880, after the check at Gheok Tepe, runs from the port of Mikhailovsk, on the Caspian Sea, to the village of Kizil Arvat, opposite the oasis of Akhal Teke. This section has a total length of 217 versts.

The city of Gheok Tepe was conquered in the beginning of 1881, by General Skobelev, and in 1883, two years later, the Turcomans voluntarily submitted. The Russian government in 1885 decided to prolong the line, and intrusted the direction of the work to General Annenkov, who entered upon the mission with extraordinary activity. Starting from St. Petersburg on the 28th of April, the general opened the first working points at Kizil Arvat on the 18th of May, and laid the first rails on the 2d of July. This activity was not arrested a moment, and in the following year, at the same date, July 2, he was enabled to dispatch the first train to Merv, which made its entrance into the station of that city.

The road had been laid out, constructed, and put in operation over a length of 325 miles in one year only. The station at Tchardjoui, on the Amou Daria, was inaugurated on the 30th of last November. The general hopes soon to inaugurate that of Samarcande, and doubtless even to reach the city of Tashkend later on. The head of the railway line on the Caspian Sea, up to July, 1886, was located at the Mikhailovsk station, but was changed at that epoch by the general on account of the low depth of the water of its port, such depth being but 7 ft. Besides, the port is surrounded with shifting sandy bottoms, that render the access difficult to it of boats loaded with material coming from the Caspian Sea. The general decided to transfer the starting point of the road to the island of Ouzoun Ada, at 25 versts from Mikhailovsk, the port of which has a depth of 10 or 12 ft.—sufficient for the largest boats. The railway was, therefore, extended to this point, where it can receive freight from boats directly. Here it crosses the sandy shallows that separate the island from terra firma, through a viaduct. It would likewise have been possible to connect the transcaspian line with the port of Krasnovodsk, the access to which is particularly sure, and which is in relation with the maritime services of Bakou and Astrakhan, but in this case it would have been necessary to construct 26 versts of railway under conditions that would at times have been very difficult. It was, therefore, preferred to adopt Ouzoun Ada as the starting point, at least provisionally.

Most of the buildings of the Ouzoun Ada station are built of wood, and the numbered pieces were shipped directly from Russia by the Volga, so that nothing remained to do but mount them upon the spot. In this way, it become possible to create, in the space of three months, a thoroughly equipped port, with its quays and appointments capable of allowing a dozen ships to be unloaded at the same time. This port is to serve as a point of transit for the passage of the materials necessary for the construction of the road, and for that of the supplies of all kinds necessary for the existence of the laborers—food, water, etc., coming from Russia. It is truly a subject of astonishment that, despite the inevitable interruptions of the maritime service, it has been possible to collect together, at opportune moments, the necessary supplies, and thus always to assure an extraordinary advance in the work of construction.

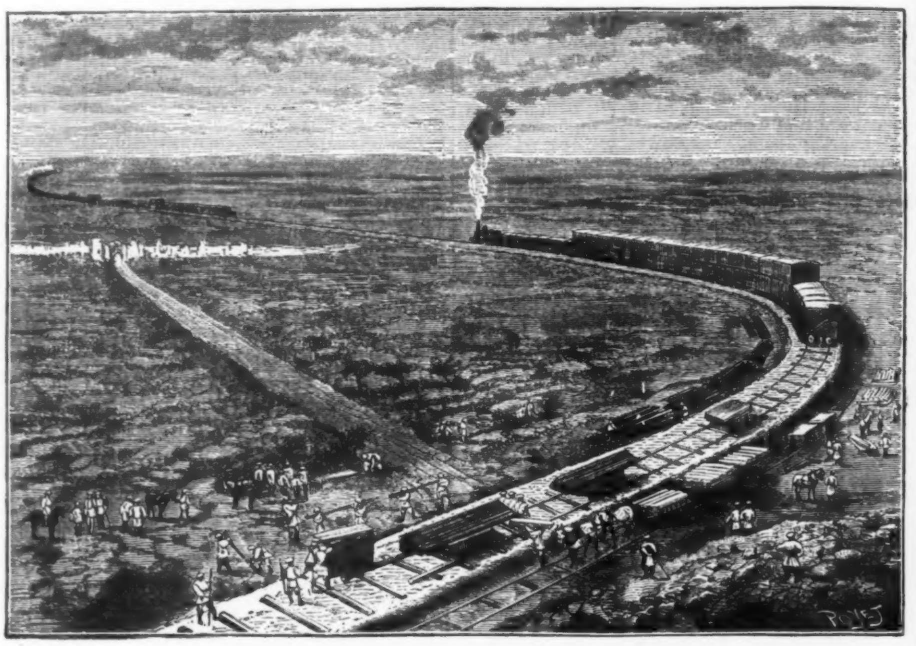


FIG. 2.—CONSTRUCTION OF THE TRANSCASPIAN RAILWAY.

It must be observed, it is true, that the line has no large bridges, crossing, as it does, only the Tedchend and Mourgab, which, so to speak, are of insignificant width. The most important crossing will be that of the Amou Daria, at Tchardjoui. But the continual presence of sand, and especially of shifting dunes, form obstacles that are certainly more difficult, and that the Russian engineers have happily succeeded in triumphing over.

The line is constructed and exploited militarily under the direction of General Annenkov, who commands the entire force—civil and military. The civil force includes two engineers of bridges and roadways, who have under their orders common and civil engineers. These latter are distributed all along the line with squads of from six to eight assistant engineers and overseers, and the construction parties camp out on their sections. In this way, in advance of the military laborers who are in charge of the construction properly so called, they form what we should style the substructure of the road, that is, the earthworks, bridges, etc. They construct the station buildings, and, on the sections already finished, it is their duty to keep the road in order. For the earthworks, which must always precede the laying of the tracks at a certain distance, they employ native laborers, and establish working stations that sometimes extend for lengths of from three to five miles. These labors are effected in a more or less perfect manner. According to the time at their disposal, the men prepare the roadbed, and sometimes excavate the lateral trenches.

After the civil force, charged more especially with the earthworks, comes the military force, comprising two railway battalions of about 1,000 men each, one of which has the laying of the rails in charge, and the other the exploitation of the line and the telegraphic service.

The arrangements adopted for laying the rails are particularly interesting to make known, as they especially explain the great rapidity with which the work has been carried forward. The track-laying battalion, to which is added 300 native laborers, is installed in a special construction train, which keeps continually at the extremity of the line, and moves forward every day a distance equal to the length of track laid on the day preceding. To use Mr. Boulangier's words, we thus have a true rolling camp that saves the men from a useless walk (Fig. 1).

When this officer visited the line, the train consisted of 35 cars, 4 of them two-storied ones, a dining car and kitchen for the officers, 3 kitchen cars, 20 two-story cars to lodge the laborers (600 soldiers and 300 natives), and 5 cars for special services—ambulance, forge, telegraph, provisions—with a special reserve for the reception of the bolts and accessories for laying a length of 2 versts. When the work was pushing on most actively, the force on the train was 1,500 men.

Every evening, a supply train of 45 cars brings everything necessary for the establishment of the length of

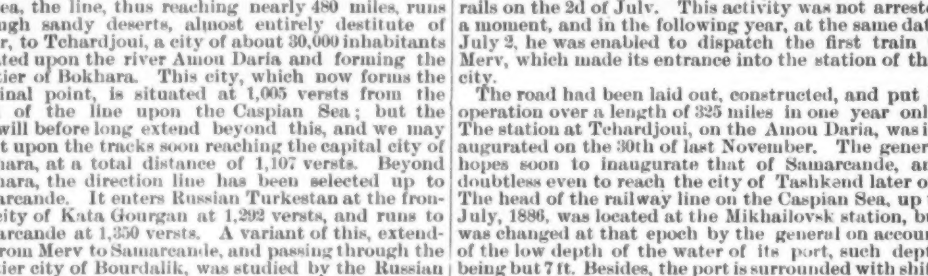


FIG. 1.—CONSTRUCTION TRAIN ON THE TRANSCASPIAN RAILWAY.

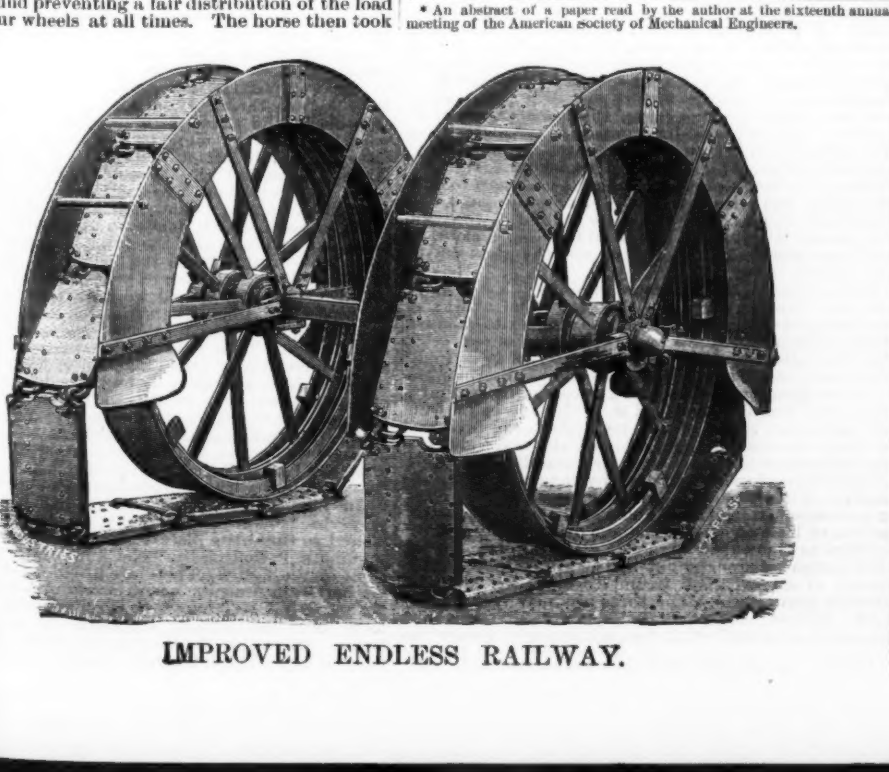
track that is to be laid on the morning of the next day (say about 2 versts), and that constitutes the work of the morning post, for the soldiers are divided into two brigades, each of which works six hours only.

The material is unloaded at the end of the line, behind the construction train, the rails on one side of the track and the ties on the other (Fig. 2). At the beginning of the day's work, the construction train backs in order to leave the road free from where the supplies are deposited. The men of the morning brigade lay upon the left side a small Decauville railway of 1·6 ft. gauge, over which run small cars loaded with ties.

The latter are thus carried to the front, and each one is placed in the spot that it is to occupy in the line. The traction is done by horses. The rails, which are 23 ft. in length, are placed, to the number of 12 or 16, upon small cars that run upon the main track in front of the construction train. They are removed one by one and fixed to the ties, and the empty car is turned over at the side of the track to allow the following one to come up. At noon 2 versts have been laid, the train moves forward this distance, and the men can thus eat without walking back to it. Another train, which arrives in the morning, is unloaded in the same way, and the afternoon brigade takes up the work, and lays its 2 versts. Fig. 3 gives a view of the line opposite Merv, and gives an accurate idea of the work. In order to assure a constant advance, even on passing stations where the track is double, the duration of each brigade's work is raised to ten hours at these special points.—*La Nature.*

IMPROVED ENDLESS RAILWAY.

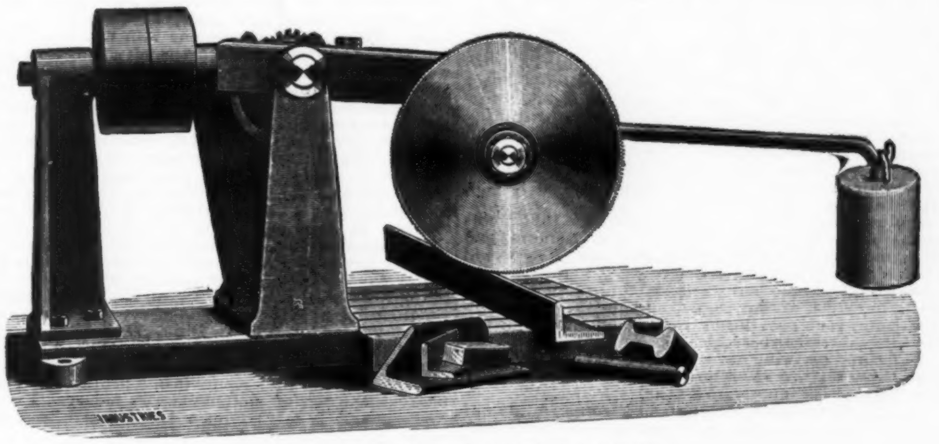
THE engraving below is from a photograph of a pair of wheels fitted with Fender's endless railway, as exhibited by Messrs. R. Garrett & Sons at the Smithfield show. Mr. Fender, who is a native of Buenos Ayres, owns land in South America, and invented the endless railway primarily for his own use, having experienced great difficulties in getting his agricultural produce to market or his machinery from the nearest town to the farms, in a country which is almost without roads, and the soil of which is in places extremely swampy and yielding. For loads from 30 cwt. to 40 cwt. it is in those districts often necessary to employ from twelve to sixteen oxen, the road taken being straight across country, over marshes or tracks of sand, in utter disregard of the miserable attempts of carriage roads which may or may not exist in certain localities. In most rural districts there are no roads whatever, good or bad, and hence there is an enormous waste of animal power, great wear and tear of the vehicles, and loss of time. With steam plowing tackle, the difficulties of getting across country are almost insuperable, the heavy engines often requiring whole days of labor to raise them out of the cavities which the wheels have dug for themselves. These difficulties induced Mr. Fender to try various old systems of portable tracks, but these were again abandoned on account of complication and liability to breakage. At last he hit upon the device which is herewith illustrated, and which has proved very successful. The first trials in Europe were made in the neighborhood of Berlin, on a farm belonging to General Von Eberstein, this particular farm having been chosen on account of the very bad nature of the land, which consists of marshy meadows and soft, sandy tracts. A cart built to carry 4 to 5 tons, and having wheels 6 ft. 6 in. diam. by 4½ in. wide, was fitted with Fender's gear, the links being 15 in. by 20 in.—that is to say, somewhat larger than those exhibited at Islington. The weight of the car without Fender's gear was 27 cwt., and with gear 37 cwt. On an ordinary level road the tractive force required for the empty cart without the gear was found by a dynamometer to vary between 100 lb. and 116 lb., but with the gear fitted it was diminished to from 80 lb. to 90 lb. A small sized horse was unable to draw the cart without the gear over sandy soil, the wheels sinking very deep. A stronger animal was then harnessed to the cart, and was just able to move it with great exertion, stopping every few steps to rest; but after fitting on Fender's gear, the same horse drew the empty cart over the ground with ease, the dynamometer indicating a tractive force of 100 lb. Hardly any difference in traction was observed when going round in a curve, and all this was on deep sand. The cart was then loaded with 44 cwt. of sand, and the tractive force was found to vary between 200 lb. and 300 lb., the great variation being due to the inequality of the ground preventing a fair distribution of the load on the four wheels at all times. The horse then took the cart with the same load over a swampy meadow, the dynamometer registering from 350 lb. to 400 lb. The wheels did not sink into the ground, but the whole surface was depressed when the wheels went over it, rising again behind like India rubber and leaving no permanent depression.—*Industries.*



IMPROVED ENDLESS RAILWAY.

AN IMPROVED COLD SAW.

THE engraving gives a general view of a simple and effective machine which has been specially designed for cold-sawing bars of iron or steel to required lengths. It is constructed by Messrs. Bow, McLachlan & Co., engineers, Paisley, and the first saw made of this design was fitted up at the works of Messrs. Lobnitz & Co., shipbuilders, Renfrew, where we believe it has given great satisfaction. As indicated by the various sections of metal shown near the saw, this machine is capable of dealing with iron or steel rails, or in fact any kind of rolled iron or steel bars or beams. The feed action is simple and effective, and can be varied by increasing or decreasing the weight shown at the end of the lever carrying the saw. The saw is driven by a worm and worm wheel arrangement, actuated through a nest of miter wheels by a pulley shaft carrying fast and loose pulleys, as shown in the engraving. As the machine is substantially built, and requires a minimum of attention, it will no doubt prove a useful tool for engineering and shipbuilding purposes generally.



AN IMPROVED COLD SAW.

PREVENTING THE FORMATION OF SCALE IN BOILERS BY THE USE OF KEROSENE.*

By F. L. LYNE, M.E.

THE action of kerosene oil for the prevention of scale in steam boilers is a subject upon which the books appear to be silent. At least the writer has been unable to find any practical data that could be made use of in determining its value as a scale destroyer. It has often been recommended, but its application for that purpose, so far, has been quite limited. Many theories in regard to its action inside of steam boilers have been indulged in by engineers, but no systematic course of treatment has yet been brought to my notice. Therefore a portion of practical experience is presented herewith in that line, with the hope that others may be induced to compare notes, and all parties concerned receive substantial benefit. In consultation with an engineer, for whom I entertain a very high regard, he suggested that I try crude petroleum, as it was better than kerosene, but he gave no plausible reason why, nor advice as to the quantity or method of introducing it. There was but one course left for me to pursue, which was to try some experiments.

At the Jersey City Electric Light Company's station we have two sectional boilers of the new Root type, 100-horse power each, and one of 155-horse power. We use the Passaic water, which makes a great deal of scale, and in the steam space I have noticed a very marked corrosive action, more especially upon the cast iron flanges of the safety-valves. Within the shell boilers which we formerly used, hard scale was formed to an alarming extent, and we could not get a scraper between the tubes to remove all of it. In the dry season salt water found its way into the reservoir, and I now have large lumps of saline matter which were removed from our boilers.

In the boilers which we are now using, hard scale would form so as to more than half fill some of the 4-inch tubes of which our boilers are principally composed. Something had to be done. I had tried several compounds, with more or less degrees of success, but still the interior of our boilers could not be kept clean. We tried blowing off, used scrapers and other devices, but without obtaining permanent relief. The deposit was mostly in the lower row of tubes, and within four feet of the back ends, near the mud drum. The loss of heat due to this incrustation was great.

Nystrom gives the following for calculating this loss:

$$H=\frac{t^2}{32\times t^2}$$

in which t equals the thickness of scale in sixteenths of an inch and H the per cent. From this it would seem that a scale of one-sixteenth would cause a loss of about 15 per cent.; three sixteenths, 23 per cent., and so on. Some have claimed the conductivity of scale to be at least 30 per cent. less than iron, hence we recognize the necessity of keeping boilers free from scale and sediment.

As a preliminary experiment with kerosene oil, I took a test tube of 1 inch diameter, and in it placed a lump of scale taken from our boilers. A tablespoonful of water was then added, with a film of kerosene upon its surface. Heat was then applied from a Bunsen burner. When ebullition began, the kerosene separated into globules and followed the sides of the tube to the bottom. Thence they arose through the center to the surface. This action continued as long as heat was applied, and proved conclusively, to my mind, that the kerosene would not remain upon the surface of water in a boiler, as has been argued by some engineers. I have since proved this correct, beyond a doubt, by drawing water impregnated with kerosene from near the bottom of the boiler. From the time the water in the test tube began to simmer, the scale commenced to disintegrate, and continued until nothing was left but the hardest substances.

I concluded from this experiment that kerosene oil was just the thing to use in our boilers, so an apparatus to introduce it was made and attached to the feed-pipe. It is an inexpensive affair, made of a piece of 5 inch iron pipe, 12 inches long, with a cap screwed upon each end as shown. A pipe at the bottom connected with the hydrant, while the pipe at the top conveyed the kerosene into the feed pipe when the water was turned on. A tallow cock was screwed into the top for filling while the air and water were drawn off at the stop cocks shown for that purpose. When the feed water is taken from a tank or well where there is no pressure to force it into the boiler, a globe valve must be placed in the feed pipe, so as to compel the water to flow temporarily through the reservoir, in the direction shown by the arrows, carrying the oil along with it. Our feed pipes used to clog up with hard lumps of scale and rust from the water, but since we began using kerosene these pipes are all clean and they do not rust. I therefore recommend that the reservoir be placed so that the kerosene may pass through all the water pipes if possible. When our apparatus was ready for use, the water was blown off from a 100 horse power boiler, the blow cock closed, and two quarts of kerosene oil introduced. The injector was then started (by steam from one of the other boilers), and as the water rose the kerosene reached every part of the interior surface. Before filling this boiler an examination was made which showed scale in the tubes of three-sixteenths to one-quarter inch in thickness, while in the headers it was half an inch thick in places. We never put cold water in our boilers, either to wash or fill them, unless they are cold, for I have known cracks to originate in steel boilers by so doing. We put in two quarts of kerosene every other day for one month, when this boiler was blown off at ten pounds pressure. It was then opened and examined, when we found that the scale was partly dissolved and loosened, so that a scraper removed most of it from the inside of the tubes. The scale in the headers remained quite hard, although the surface was softened by the action of the kerosene. The blow-off cock was then closed, and two quarts of kerosene put in, after which the boiler was filled with water as described. The object of putting in the kerosene first is to have it penetrate the scale and loosen it as the water rises, and we know that it does this. During this second month we used the same quantity of kerosene, and in the same way as the first month. At the expiration of that time the water was blown off, and an examination revealed the tubes perfectly clean. There was, however, some

* An abstract of a paper read by the author at the sixteenth annual meeting of the American Society of Mechanical Engineers.

scale left in the headers, but it was so soft that it could be easily removed with the finger nails. We used no scraper this time, but just closed it up, put in two quarts of kerosene, and filled it as at first. During the third month we blew down two gauges of water every week, and used the same quantity of kerosene as before. At the expiration of the third month we blew off the water and opened the boiler, when, to our satisfaction, we found it *clean*—a condition that never before existed since we started the boilers. The dirt had all settled in the mud drum, and when the blow-off cock was opened, it passed into the sewer. Not a teaspoonful of sediment was found inside this boiler. I closed this boiler and ran it three consecutive months without opening the blow-off cock or changing the water during that time, using the same quantity of oil as before. At the end of the three months the water was blown off, and no dirt was found in the tubes, and very little soft mud in the mud drum. This, I thought, was a very conclusive experiment. We then adopted a rule of one quart of kerosene per day for each of the 100 horse power boilers, and three pints for the 155 horse power boiler. The water is blown down two gauges every week, and the entire contents every month. Water is never used to wash them out, nor is a scraper necessary, for the mud all goes out with the water. An examination is made of the interior, and we put them to work again. This is a wonderful relief to us, for the reason that no scale forms in any of our boilers, and the corrosive action mentioned as having existed at first has entirely ceased.

Another thing worthy of special notice is that it was impossible to keep a glass water tube in use more than three months at a time, and oftentimes they would break within two months. Before using kerosene these tubes would become badly grooved and eaten away at the upper ends, so that they would break. Our engineer came very near losing his eyesight through the breaking of one of these glasses, and his face was badly disfigured by being cut with the broken glass. Now these tubes do not show any such action, and they have been in use more than a year.

I admit that rubber packing and kerosene oil do not agree, so to guard against any trouble from that source I had new nuts, 1½ inches deep, placed at the ends of the glass tubes, and used asbestos wicking dipped in boiled oil, and then squeezed dry, for packing. They do not leak, and these joints are permanent.

I never use rubber packing in flange joints about a boiler, or in any place where it comes in contact with steam. For faced joints I insert asbestos in sheets, one-sixteenth of an inch in thickness; and for rough joints the same material one-eighth inch thick. After purchasing the asbestos I spread upon both sides, with a brush, all the boiled oil that it will readily absorb, and then hang up the sheets until required for use. When a gasket is needed, we cut it to the required size, then rub both sides well with pure graphite, and screw it up hot, after which no more attention is required. We have joints made in this way which have been in use more than three years, and as yet have shown no sign of leaking. I took some of them apart recently, and the surfaces separated very nicely, and there was no evidence of rusting or corrosive action upon them. A short time since, one of our neighbors had a great difficulty in making a joint upon a badly rusted mud drum of a shell boiler, and it could not be kept tight for any considerable length of time. He made a gasket of asbestos prepared as described, and has not touched it since.

In taking apart our flanged joints we broke no bolts nor split any nut, as is usual with such joints made in the ordinary way; for when these joints were made we smeared the threads and nuts with graphite mixed with boiled oil. A small quantity of this substance rubbed upon the stems of safety valves will prevent them from sticking or corroding. A small monkey wrench easily removed the nuts, and none of them were rusted. This is the way we treat all of the nuts and bolts upon our boilers, and the same mixture is used in putting up steam pipes. The result is that we break no fittings, nor do we split any pipes in taking them down after years of service. I am aware of instances where graphite used upon iron surfaces has shown, when taken apart, a sort of hard scale, having the appearance of some sort of cement. This is liable to occur when the graphite contains foreign substances such as silica and sulphur. The common, cheaper forms of graphite will not give satisfaction for these purposes. It must be pure. The kind that I use, and have used for the past fifteen years is made by the Dixon Crucible Company, who have a special process by which they remove all earthy and mineral substances, leaving the flakes of graphite pure. I have never had any unpleasant experiences with this grade of graphite, and have used it extensively, not only as described above, but also in the cylinders of steam engines.

In conclusion, I desire to say that crude petroleum has, to my certain knowledge, been used in steam boilers during the past eleven years and upward, where, with judicious application, it has been successful in removing and preventing scale. While this is admitted, I must also acknowledge that great damage to boilers has resulted by not observing the necessary precautions in the quantity put into the boiler each time. I will mention but one instance, which is that of a tug-boat now running in New York harbor. The boiler was badly scaled, and some one advised the engineer to use crude petroleum; so he "gave the boiler a good dose," as he said. In a few days the tubes began to leak, and the crown sheet bagged down. The boat was then laid up, when it was found that the heavy oil had mixed with the mud, and had formed a paste on the crown sheet. This paste kept the water from reaching the plates. Hence the result stated above. This paste was so dense that water from a hose would not dislodge it; and I do not hesitate to say that, had kerosene oil been used in this instance instead of crude petroleum, the boiler would not have been injured. The reason is that there is not sufficient body in kerosene oil to form a paste. The chief objection to crude petroleum is that it is too heavy, while in kerosene oil there is no substance which will stick fast to the interior of a boiler.

In it we find all that is necessary to accomplish the desired object without the objectionable features just mentioned. I appreciate the fact that there may be instances where steam is blown directly into fibrous materials in the course of their manufacture, and also in the preparation of articles of food, where the odor or possibly the taste of kerosene oil might be disagreeable; but such instances are few when compared with the many where it might be successfully employed for the prevention of scale in steam boilers. Some engineers advance very queer theories against the use of kerosene; but I must assert that, for the most part, they are only imaginary. We have as yet found no objections in our experience. Our boilers do not lift their water, they are free from scale, and our fuel bill is thereby greatly reduced.

[Continued from SUPPLEMENT, No. 631, page 10076.]

GLASS MAKING.*

By C. HANFORD HENDERSON, Professor of Chemistry and Physics, Philadelphia Manual Training School.

FOLLOWING the order given in our table, we shall next take up the manufacture of plate glass, and for this purpose I shall again ask your presence in Pittsburg. This time, however, our visit will be to Creighton, some twenty miles from the city, and near to the well known natural gas district of Tarentum. There are in this country four large establishments where plate glass is manufactured. The Creighton plant has the reputation, however, of enjoying the most favorable economic conditions, and it would certainly be difficult to find in this or any other country one more completely equipped. The glass itself has the same constitution as the sheet and crown glass. It is simply a double silicate of lime and soda. The melting is carried out in large open pots, the furnaces differing in their construction from those already described only in their greater size and the substitution of doors made of fire clay tiles set in cast iron frames for the usual gathering holes. When the fusion has been completed, the door opposite the pot is opened, and a two-pronged fork, mounted on wheels, is inserted into the furnace. The distance between the prongs is sufficient to permit them to pass into depressions made in each side of the melting pot, and thus secure it in a firm grasp. By this method, the pot of molten glass is removed from the furnace, and is carried on a low truck to the casting table.

At Creighton, the casting house, containing furnaces, tables, and annealing ovens, is 650×160 feet, about four times as large as the famous *halle* of St. Gobain, in France, and nearly double the size of the British works at Ravenhead. There are two casting tables at Creighton, 7 inches thick, 19 feet long, and 14 feet wide. Each is provided with an iron roller, 30 inches in diameter and 15 feet long. Strips of iron on each side of the table afford a bearing for the rollers, and determine the thickness of the plate of glass. The tables are mounted on wheels, and run on a track which reaches every furnace and annealing oven. The table having been brought as near as possible to the melting furnace, the pot of molten glass is lifted by means of a crane, and its contents quickly poured on the table. The heavy iron roller is then passed from end to end, spreading the glass into a layer of uniform thickness.

As rapidly as possible, the door of the annealing oven is opened and the plate of glass introduced. The door is then closed, and the glass left to anneal. All of these operations are performed in little more time than it takes to describe them, as it is desirable to get the glass into the annealing oven as hot as can be. A large number of ovens are required for annealing purposes, as the glass must remain several days to cool. When the glass is taken out, its surface is found to be decidedly rough and uneven. A small quantity is used in this condition for sky lights and other purposes where strength is required without transparency. It is known in the market as rough plate. The greater part of the glass is ground, smoothed, and polished before it leaves the works. The grinding is accomplished by means of rotary grinding machines, the abrading material being common river sand dredged from the Alleghany. Three million bushels are required annually for this purpose. The plates are firmly fixed on large rotary tables or platforms by means of plaster of Paris. Rotating disks are so arranged that they cover the entire surface of the glass at each rotation of the platform. Small jets of water keep the grinding sand always wet. These operations remove the rough exterior. The smoothing is accomplished by emery, finer and finer grades being used as the process proceeds.

The final polishing is done by means of rouge (carefully calcined sulphate of iron). The monthly product of the Creighton plant is about 100,000 square feet of glass. The fuel throughout the entire works is natural gas, which here displaces about 3,000 bushels of coal daily. It is used in melting furnaces and annealing ovens, as well as in supplying the steam for engines of about 1,500 aggregate horse power. These figures will give you some idea of the magnitude of the operations connected with a large factory and will perhaps dispel the notion, if such exists, that we are largely dependent upon France for our supply of plate glass. The output of this factory, though so large, finds ready market, and is never greater, I understand, than the demand; for the American plate glass can compete both in quality and price with that of European make. At Creighton a part of the output is utilized in the manufacture of mirrors, and improved beveling machinery has been introduced in order to give the glass the desired finish.

The subject of colored glass windows is a very large one, and whether viewed either from the artist's or technologist's standpoint would be difficult to exhaust. In its nomenclature, we have permitted ourselves to fall into rather careless habits. The terms "painted," "stained," and "mosaic" glass are used indiscriminately to designate any glass work involving color, but a moment's consideration will show them to be far from synonymous. Some of our best effects are produced without the use of either paint or stain, and they have the advantage of a much greater durability. In painted glass the colors are obtained by enamels fused to the surface of the glass by means of heat. In stained glass, a permanent, transparent color effect is secured by the action of heat on certain metallic oxides applied to the surface as pigments. In mosaic glass, pure and simple, the design is brought out by the use of shaped fragments of colored glass bound together by strips of doubly groved lead. The three products, you see, are quite distinct. It frequently happens, and in the older examples of ecclesiastical design it is nearly always the case, that all are combined in one window. But at the present time there is a strong reaction against the employment of either stain or paint, since they are less durable and less brilliant than homogeneous colored glass. The tendency is very decided to rely entirely upon the mosaic treatment, and to limit the use of paint to the representation of the human body. Even here it is reduced to a minimum by employing a translucent glass and shading sparingly in monochrome. A light reddish brown is the favorite tint. It has the disadvantage of giving a statue like sameness to all the figures. Should the present taste continue, our picture windows promise to become an assemblage of rather monotonous blond types.

The manufacture of mosaic glass at the present time has attracted the attention of men of such ingenuity and taste that it deserves its rank among the fine arts. It has attained a degree of artistic perfection of which the earlier examples gave little promise. In spite of the abandonment of paint and stain, the mosaic glass has been given greater variety and greater depth of color than at any time since the renaissance. The glass itself has been made in all the colors of the spectrum, and has undergone a thousand different transformations. By the mixing of several colors when the glass is no longer liquid, curious mottled effects have been produced, while the addition of cryolite and other indissoluble substances has given us the opalescence so much admired in the art glass work of the last few years. The shapes have been no less varied than the colors. The so-called "jewels," or pieces of richly colored glass, cut with facets after the manner of precious stones, have added immensely to the brilliancy of modern designs. I had recently the pleasure of going through a factory for colored glass in Brooklyn, probably the largest establishment of the kind in this country, and I assure you that it was a chromatic treat to visit their storerooms, for 500 different color combinations were recognized in their stock. The mosaic ateliers of the Vatican contain, it is true, some 26,000 different tints; but these, you must remember, are simply opaque enamels, while the glass of which I speak is all easily translucent, and much of it is clearly transparent. Time will not permit me to give you anything like an exhaustive description of this branch of glass manufacture, but the subject is far too interesting to be passed over in silence. The basis of the process is, as before, a lime-soda silicate, the coloring being due to the addition of soluble metallic oxides. Taking them up in the order of the spectrum, the violet shades are generally produced from manganese or from small quantities of cobalt; the deep blues, indigos, purple blues, and normal blues are obtained from varying proportions of cobalt; peacock blue from copper, the finest greens from chromium and copper, and the dull sea water tint from ferrous oxide. The yellows come from a variety of sources. The sesquioxide of uranium gives a fluorescent yellow; the oxide of lead, a pale yellow; the oxide of chromium, an emerald green; and the oxide of silver, applied as a pigment to the surface of the glass, a permanent yellow stain. The higher oxide of iron gives an orange color, but as it has a strong tendency to become reduced, it is necessary during the manipulation of the glass to keep some oxidizing agent present, such as manganic oxide. In the reds, a number of excellent shades are readily obtainable. Manganese furnishes a variety of pinkish reds and pinks; copper in its lower oxide, the fine blood red of Bohemian glass; and gold the most brilliant of all reds, the well known ruby color. In addition to these, a number of other substances are used to produce either colors or unique effects. A little carbonaceous matter yields an amber tint of very agreeable hue, while the opalescence now so much in vogue results from the presence of oxides of tin, arsenic or lime, or from native minerals, such as fluorite, or the cryolite imported in such large quantities at the present time from Greenland. If simply colored, transparent sheet glass is to be made, the molten metal may be gathered and blown into cylinders in precisely the same way as in the manufacture of window glass, but in mosaic glass it is now much preferred that the glass employed should not be transparent, or but imperfectly so, since the color effects are much richer from uneven surfaces. The most of the glass is therefore cast, the process being a repetition in miniature of the casting of rough plate. The pots containing the molten colored glass remain, however, always in the furnace, and the metal is dipped out in small iron ladles. It is poured at once on a little casting table, and is smoothed out by means of an iron roller. The sheets being so small are readily handled and permit the use of the convenient rod leer. In case more than one color is to appear in the same sheet, the effect is obtained by mixing the several masses of plastic glass on the casting table by means of a copper implement not unlike a plasterer's trowel. In this way three or even four colors are mixed together in the same piece of glass, and though the results are always more or less experimental, artists have learned to adapt them not only to their geometrical designs, but also to their picture windows as well. The workmen have attained no little skill in the art of mixing. The blue and white translucent glass in particular is made to represent sky effects almost as naturally as if the colors had been laid on by an artist's brush. From the factory the glass is taken to the studio. A number of preliminary steps must be taken before the actual work of putting the glass together can begin. The artist first makes a sketch of his design, and then, if satisfactory, enlarges it to the natural size. This working drawing is then colored and divided up by broad black lines representing the strips of lead necessary to hold the pieces of colored glass together. The cutting of the glass is a severe tax upon the judgment, and has to be carried out under the immediate supervision of the artist. In geometrical designs, the requirements of color harmony alone need attention; but in picture windows, in addition to this, a very appreciative eye is needed to seize upon just the right combinations to bring out the draperies, background, and sky, for no paint or stain is used in the entire picture except the monochromatic shading representing the head and other exposed portions of the figure. There are in this country a number of establishments where work of such a character is done. The Tiffany Glass Company, of New York, have been particularly successful in adapting the mosaic treatment to picture windows. They have recently reproduced Gustave Dore's famous painting,

* A lecture delivered before the Franklin Institute, January 10, 1887.

"Christ leaving the Prætorium," for a church memorial window, the entire piece being executed in pure mosaic, with the exception of the faces and hands. The dimensions of this truly magnificent work of art are 20 × 30 feet. It is the most ambitious window ever attempted in America, and indeed the largest opalescent piece in the world.

The glass employed in optical instruments must be as dense as possible, since its refractive power increases with its specific gravity. We employ for this purpose, therefore, a mixture of the silicates of lead and potash. But as these compounds differ greatly in their respective densities, much care must be taken to prevent their separation, and the consequent streaky structure which would result. The sand, red oxide of lead, and potash having been mixed in the proper proportions, that is, so as to produce a glass having approximately a composition represented by the formula $PbO,K_2O,6SiO_2$, are introduced in small quantities at a time into a melting pot provided with a dome-shaped cover.

This excludes smoke and other impurities and at the same time prevents the furnace gases from reducing the lead to the metallic state. During the fusion, the mass is frequently stirred by means of a fire clay cylinder, attached at right angles to a long iron handle. When the fusion is judged to be complete, the furnace is reduced to a lower temperature, and the melting pots permitted to remain at rest for perhaps a couple of hours, in order that all the bubbles throughout the mass of glass may come to the surface. A constant stirring is then maintained for another two hours. In the meanwhile, the temperature falls so low that the stirring toward the end of the period becomes quite difficult. When the operation ends, the clay cylinder is withdrawn, all the openings to the furnace are closed up, and crucible and contents are allowed to gradually cool. This requires about a week. The crucible is then taken out and carefully broken, so that it may be separated from the mass of flint glass. Parallel faces on the sides of the mass are ground and polished in order that the internal defects may be located, and the glass cut up to the best advantage. Those who have been interested in watching the equipment of the Lick Observatory on Mount Hamilton, in California, will perhaps remember the repeated trials that were necessary before the glass for the great telescope could be successfully cast and placed in the hands of Alvan Clark for grinding. The subsequent processes of adapting the material obtained at the cost of so much labor and expense to optical uses, though of much interest, scarcely come within the limits of to-night's inquiry.

Of the flat ware, then, a word only remains to be spoken concerning the pressed decorative pieces now used with such excellent effect in domestic architecture and in the ventilators of the newer designs of cars. The process of manufacture is very simple. The molten colored glass is taken from the crucible in a small ladle, and by virtue of the rapid cooling induced by contact with the cold iron, is in a condition of plasticity by the time it reaches the press. Here it is quickly pressed between the two pieces of the mould, the excess of glass being squeezed out between them in so thin a sheet that it can readily be detached from the finished product. Quite a variety of shapes and designs are now manufactured. Rectangular pieces, stamped with simple flower or geometrical designs, are becoming quite popular for small windows and transoms. Circles, squares, and other pieces are also being made in quantities for introduction into mosaic glass work, and form an agreeable feature in the design.

In the manufacture of hollow ware in glass, we have two distinct processes producing characteristic products, the blown and the pressed glass. The first of these includes all vessels which owe their form to the blower's breath In considering the manufacture of window glass, we have seen the facility with which a mass of glass when in a plastic state may be made to expand into a hollow globe or cylinder at the will of the operator. This same agency, the blower's breath, when a little more daintily applied, furnishes our tables and laboratories with the manifold forms of glass ware which add so much to our daily convenience. In its chemical composition, the glass used for this purpose varies considerably. The celebrated Bohemian glass, which cannot be surpassed in brilliancy by crystal itself, is a silicate of potash and lime with small quantities of iron and alumina. Much of the commoner table ware is similar in its composition to window glass, but possesses little brilliancy and has frequently a greenish cast, due to the presence of the lower oxide of iron. The so-called crystal, which in England is sometimes denominated flint glass, owes its weight and refractive power to the presence of silicate of lead. Like the product employed for optical purposes, it is in the main a double silicate of potash and lead, but contains less lead than the latter glass, and has consequently a lower specific gravity. It is the material employed for the fabrication of cut glass and the finer grades of table service.

In the manipulation of the plastic metal, two methods offer themselves to the choice of the glass worker. In the one, he forms his articles entirely in the air by the dexterous use of a few simple tools, and in the other he depends upon a cast iron mould to give the desired shape to the exterior, while the interior is formed by the pressure of his breath.

The use of moulds, though common in the manufacture of the cheaper grades of glass ware, and of much importance in bottle making, is prohibited in the case of the finer goods, since it robs the glass of much of its brilliancy. There is a peculiar polish, which comes from working the glass in the air, not unlike that characteristic of crown glass. It is more than sufficient to compensate for the greater time required by the process. The blowpipe used in making these smaller articles is a light wrought iron tube, from four to five feet long and having a diameter hardly greater than one-fourth of an inch. The mass of molten glass gathered on the end of the blowpipe is compressed and worked into symmetrical shape, by being rolled on a marver. A little air introduced into the interior of the mass transforms it into a bulb, which is then lengthened by swinging. So far, the process is the same, whatever may be the ultimate form impressed upon the glass.

The subsequent treatment of the bulb is determined by the shape of the article which it is desired to produce. If, for instance, a wine glass or goblet is to be made, the bulb is extended to the proper size to form the bowl, and the stem formed either by drawing out a part of the substance of the bulb itself, or by attaching a small mass of glass to the bottom of the bowl, and while still red hot drawing it out into the desired shape. The glass worker distinguishes the first as the "straw stem," and the second as the "stuck shank." The partly formed goblet is now ready for its foot. This is either blown or cast, the choice being quite independent of the nature of the stem. The blown foot is formed on a separate blowpipe, and when attached to the stem is simply a bulb of glass somewhat smaller than the bowl. The bulb is then opened, and by a rapid twirling of the glass expands into a circular plate forming the foot of the wineglass or goblet. The addition of a cast foot is brought about in a somewhat different manner. A small mass of molten glass is dropped on the end of the stem, and is flattened into the requisite shape by being pressed between slabs of wood or prepared carbon. The original blowpipe is now separated from the upper half of the bowl, and the rough edge of glass trimmed off by means of shears. In case the article to be manufactured is a pitcher, or other vessel with a handle, the hollow body is first formed, and the handle generally added in a separate piece. This is attached at one end to the glass, and is drawn out to the desired thinness. The requisite length is then cut off and the free end made fast to another part of the glass vessel. There is in this department an immense variety of shapes and sizes manufactured, each style calling into play some particular adroitness in the management of the molten glass. All of the tools employed are extremely simple, the results depending almost entirely upon the manual dexterity of the workman.

The pressed glass in hollow ware is a variety attaining increasing importance. It is not so brilliant as the blown glass, but at the present time is made in very attractive shapes, and has the merit of low cost. The process of manufacture is similar to the pressed window pieces. The red hot plastic glass is pressed between a fixed mould and a corresponding plunger actuated by hand power. In the flat pieces, such as dishes and plates, the designs used in cut glass have been reproduced with fair success. They can readily be detected, however, from the genuine article by their inferior brilliancy, and also from the indistinct, rounded appearance, which in glass seems inseparable from angles produced by fusion. In the case of decanters, cruets, and the like, made to imitate cut glass by being blown in moulds, the deception is now frequently heightened by the use of real cut glass stoppers. The practice of cutting and grinding the facets in pressed glass has prevailed to some extent, but the surfaces so treated lack the brilliancy of the uncut glass, and so gain little by the operation. The genuine cut crystal, whose rainbow beauties have made it admired above all other products in glass, is made either from blown ware or from pressed, with perfectly plain surfaces. In this way the cutting is made to penetrate beneath the chill produced by the mould, and to develop the full chromatic possibilities of the glass.

The manufacture of bottles is a distinct and very important division of the making of hollow ware. It is nowhere in America carried on so extensively and so successfully as in the neighborhood of Philadelphia. Much of the sand of Southern New Jersey is sufficiently pure to make an excellent bottle glass. Its adaptability for this purpose seems to have been appreciated by the early settlers, for the oldest glass works in this country are those established in 1775, and Glassboro. These works, the property of Messrs. Whitney Brothers, are also at the present day the most extensive, employing, as they do, some 600 persons in the conduct of their operations. It is a significant fact, showing the force of modern progress, that, after existing for more than a century, the capacity of the plant has been increased more than 50 per cent. during the past three years. As this gratifying result is largely, if not entirely, due to the introduction of improved furnaces, invented by the chemist of the works, Mr. Andrew Ferrari, I shall call your attention briefly to their construction. They are, in a word, tank furnaces, heated by gas. Neither the employment of a tank in place of separate crucibles nor the substitution of a gaseous for a solid fuel is in itself new; but the details of the Ferrari furnace are quite novel.

In Europe the regenerative system of Siemens has been employed with marked success in the manufacture of glass, but unfortunately the Siemens furnaces are expensive in their construction, and require some degree of skill to insure their best working. The Ferrari furnace is an inexpensive affair, and possesses several features of decided advantage. The gas generator is the usual inclined or "step" grate employed by Siemens, but is placed directly alongside of the furnace, thus obviating the transportation of the gas and the necessity of reheating it before being burned.

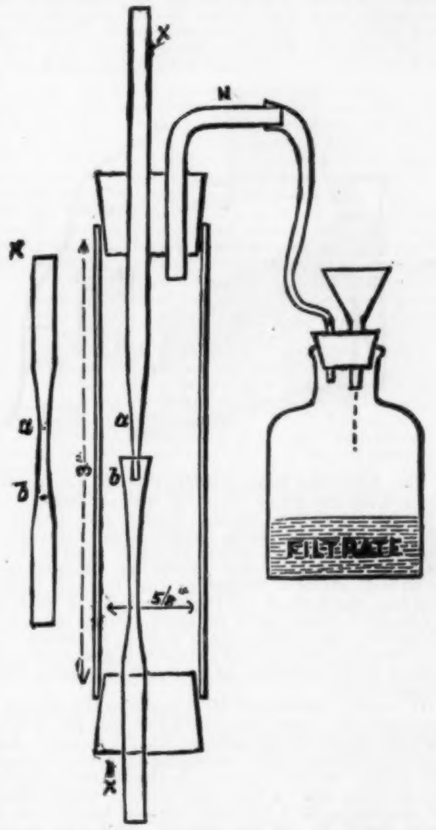
The carbon of the coal is burned on the grate to carbon dioxide, and rising through the mass of incandescent fuel above it, is reduced to the monoxide, and with the volatile hydrocarbons given off passes at once to the melting chamber above the tank. The air necessary for combustion is heated by passing through chambers in the lower portion of the furnace. It is mixed with the combustible gases just before they reach the fire clay bridge separating the generator from the melting tank. The operation of the furnace is continuous. The crude materials of the batch are introduced at intervals of three hours, about two and one-half tons making up the charge. As the material melts it sinks to the bottom of the tank and flows through small openings leading to the gathering chamber beyond. The glass resulting from the fusion of the sand and alkaline bases has a specific gravity greater than the crude material from which it is formed, and consequently seeks the lowest level. In this way, the tank, though filled with material in all stages of transformation, has always at the bottom a bath of thoroughly fused glass. The communication between tank and gathering chamber is so arranged that the fluid glass alone can pass from one to the other. There are three Ferrari furnaces in operation at Glassboro, the largest of which has a capacity of fifty tons I am told on very reliable authority that not only is the quality of the glass much improved by the employment of these furnaces, but that in addition the experience of three years has shown their maintenance and operation to be notably less expensive than the old style pot furnace. During July and August, the furnaces are out of blast, as the heat is too great to permit the men to work. For ten months, however, the operations are continuous, the necessary repairs being so light that they do not interfere with the work. In its composition, three grades of bottle glass are recognized. The ordinary green glass is obtained from a charge of 100 parts of sand, eighteen parts of sodium carbonate, twenty-two parts of sodium sulphate, and twenty-four parts of lime. As no bleaching agents are employed, the iron present in the sand gives the glass its characteristic light green color. The second grade, the amber glass, has about the same composition, but is colored by the addition of about three-eighths of one per cent. of carbon. The finest of the bottle glass—the so-called flint glass—is obtained from a charge of 100 parts of sand, thirty-five parts of refined soda, and twenty parts of limestone. Manganese dioxide, arsenious acid, and nitrate of soda are used as bleaching agents. The bottles are formed entirely in moulds, the blower's breath giving shape to the interior. Where the bottles are very small, one man is able to blow as many as 400 dozen in a day, but this means very dexterous work.

The glass markets of to-day are particularly rich in unique products. The fine cameo ware, made by casing colored glass objects with a layer of another color, and cutting away so much of the second layer as to leave the design in delicate relief; the filigree ware, the aventurine vases, the frosted ware, the crackle ware, the spun and woven glass, and a hundred other beautiful and ingenious varieties of glass work, all have stories of wonderful interest to tell, had we but time to question them. In its employment for utilitarian purposes as well, glass has shown itself quite as adaptable as in the ornamental arts. Every day brings so many propositions for the application of the material to some new pupose, such as for fence posts, railroad sleepers, and the like, that I may safely leave the completion of the list to your imagination. Of the use of glass in the construction of houses, you have all probably received some hint, as well as what the persons who live in such houses should not do.—*Journal of the Franklin Institute.*

SIMPLE FORM OF FILTER PUMP.

By ROBERT LAW.

A VERY simple and efficacious form of filter pump can be made as follows: Select a piece of stout glass



tube, 3" long and ⅝" bore; fit this with corks, one with two holes, the other with one hole. Now take three pieces of ordinary glass tubing $\frac{1}{16}$" bore, and draw two of them out as shown in Fig. 1; cut the one at *a*, and the other at *b*; bend the third piece at an angle of 90°. Insert *x a* and the bent piece through one cork and *x b* through the other, so that *x a* will project inside of *x b*. Attach *x a* to a water supply. On allowing water to run through the apparatus, a vacuum will be caused in the tube, N, and, if connected as shown in sketch, filtering becomes a great deal more pleasant. I have found this apparatus to work very well. It gives a vacuum = 28·5" of Hg.—*Chem. News.*

IMPROVED TAR FURNACE.

MR. GEORGE ANDERSON, of Westminster, in the London *Journal*, gives an account of a furnace of his device, which he has used with marked success.

The successful burning of tar without smoke, without clinker, without too much or too little heat, is one of the simplest things a manager has to do, and certainly the easiest fire for a stoker to attend to, and produce from ninety gallons of tar heat equivalent to that yielded in the combustion of a chaldron (say twelve and one-half hundredweight) of coke.

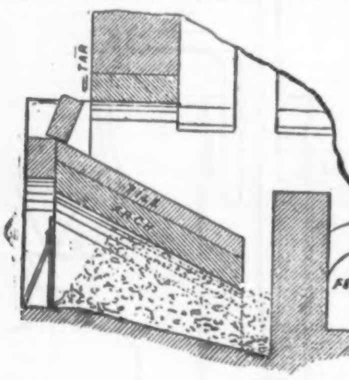
First, as to the supply of tar. No filtering or other ingenious nonsense is required, provided the tar be kept as clean as it is produced. But if you allow chips of wood, dust, or other nastiness to get mixed with the tar, then you must devise some method of getting rid of the difficulty you have created. Secondly, the tar

must be kept at an even temperature, especially providing against cold, for tar alters its character very much by change of temperature—when hot being very fluid, when cold becoming almost solid. As the stream of tar to heat nine retorts is only about $\frac{3}{16}$" in diameter, common sense points out that tar supplied at different temperatures in the same day cannot result in a constant and equal stream, which is what is wanted.

The greatest bugbear is cold, for then the tar thickens and stops. The tap has then to be further opened, and this makes smoke. But all this is easily prevented, and if the tar is not allowed to get below 80° or 90° F., there will be no difficulty. But, as I have frequently seen, if you have a small tar tank on the top or convenient to the retorts, into which you are sometimes pumping tar from a cold source and sometimes not, it results that the temperature of the tar is continually varying. But, again, this is one of the difficulties of our own creation. I prefer to work from a tank that will hold 1,000 or 2,000 gallons, and carry the flow of tar from the hydraulic main into it, only filling it from other sources when the consumption of tar is greater than the make, and even then it is better to pump the tar into the hydraulic main, and let it run from thence into the supply tank.

Then, with respect to the furnace, this must be one in which coke cannot be burned. If both coke and tar be burned in the same furnace, you never know what you are doing. Moreover, coke and tar are fuels so totally dissimilar in character that I think no man of any sense would say they should be burned under the same circumstances. Nevertheless, the tar furnace is very simple—merely consisting of an inclined plane, down which the tar runs, presenting a new surface every moment, that it may lick up the large amount of oxygen it requires to produce combustion free from smoke, and at the inner end of the inclined plane—viz., at the back of the furnace—it receives what would in these days be called "regenerated" air, but which is merely highly heated air, from having passed through and over the red hot breeze with which the ash pit is filled, being debris from the furnace that has been pushed down from the furnace through the passage at the end of the inclined plane.

I send with this a longitudinal section of a furnace, which will explain all this. The width of the furnace may be 12" to 18", as circumstances will allow; remembering that there should never be a center retort close down over the furnace, or it will not last long. A retort so placed will not injure the furnace, but the furnace will it; so that people can please themselves. I prefer, however, for many reasons, to have 3' of space over the furnace, whether with a coke or a tar fire.



The following is an explanation of the drawing: Set out the ash pit to 12" or 15" wide. Turn an arch over it, as shown, having 3" or 4" rise, terminating about 6" from the back bridge. Carry up the side walls of the furnace, giving 15" to 18" width. On the arch lay tiles as shown. Form an opening in the front wall about 9" square as the furnace doorway. Fill into the jaws of the projecting part of the furnace a couple of bricks, with ordinary luting, opposite the 9" opening, and within about 2" of it, as shown. Drop two or three pieces of coke on this 2" space; the tar to run on to these pieces of coke, and down on the inclined planes.

In starting a furnace, fill it and also the ash pit with red hot coke, close the sheet iron ash pit door, and turn on the tar at the rate of sixty to ninety gallons per twenty-four hours, according to whether you have six or nine retorts to heat. As the tar breeze forms in the furnace, push it back, and remove some of the coke if necessary. In a few days enough breeze will have been made to fill the ash pit; and this must be trimmed close up to the sloping arch over the ash pit; so that the air passing in must pass through the hot breeze before it enters up the space behind the slope. Every three or four hours the fire requires attending to. This consists in shutting off the tar, taking away one or if need be the two bricks in front at the furnace mouth, and with a sharp light bar cutting and thrusting into the furnace a crust of breeze that has formed a few inches within the mouth; putting up the two bricks again and the bit of coke and turning on the tar. When so much breeze has been shoved to the back of the furnace as covers the space between it and the ash pit, the ash pit door has to be lifted away, and a rake passed over the breeze in the ash pit, and that in the furnace hauled down into it. The breeze is trimmed up to the arch again, and perhaps a shovelful at the front taken out to admit of the door being put back.

The breeze in the ash pit must always be red hot, and the quantity of air admitted there, as also where the tar runs in, just what complies with this condition, and gives a clear chimney top. A furnace usually makes from thirty to forty pounds of breeze every twenty-four hours, though in certain instances it is sometimes almost absent, and a shovelful of coke has to be added to the ash pit to keep it full. I have an instance of this kind just now at one of my works; and, conversing upon it with my son Bruce, he suggested that it indicated perfect combustion, as the tar contained none of the ash of the coal, but only the fuel elements of carbon and hydrogen, which can all be volatilized by heat; in other words, some tar breeze burnt in a crucible should not leave a residuum. Perhaps some one would prove whether this is so; for, if so, the ash pit breeze from a tar fire might be more valuable for the manufacture of electric lighting carbons than the forms of coke out of which they are now made.

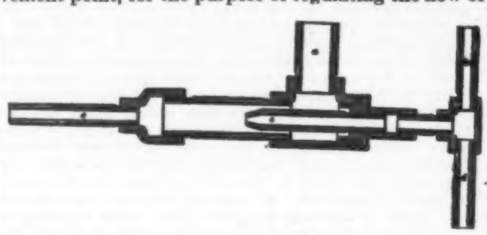
I hope I have made this very simple matter intelligible to gas managers. Still, however, I do not suppose that a furnace started without one experienced being by would be unsuccessful. But success may be only partial for some time, for in the manipulation of any process there are fine points of shade that are almost impossible to either convey in words or be correctly received in words. I have thus far formed my ideas into words. The reader has to reform these words into ideas, and in these transformations there may be some transmutations. But perseverance will easily remove any error, if the mind be given to it.

I did not take out a patent for the furnace. It has ever been free to all, and though I have used it annually for thirty-three years, I have never made any improvement in it, because I have not been able to do so. In these years I have learned a few of the "wrinkles" I have described as to the character of tar, for, at first, I too thought the tar required filtering, but I was never so daft as to let in water with it, as some do, nor to inject it in with steam as others have done, nor have I found it necessary to design any peculiar tap. The whole thing is too simple for the exercise of any mechanical ingenuity.

I may state, in conclusion, that the conversion of a coke fire into a tar one, or *vice versa*, is the work of two or three days for a bricklayer, and is done without touching the retorts, so that, in refurnacing, I build one or the other to suit my needs. Neither do I look on it as "a shame to utterly destroy the source of so much that is beautiful," when I make up my mind to burn tar, any more than does the Eastern mason when he converts a block of marble into a doorstep or lintel, while he knows that it could be made into a beautiful statue, or the builder who converts the pebbles of the seashore into a block of concrete to be buried in some vile foundation, knowing all the time what a "beautiful" polish some of them could take. I leave all these notions to fine writers, contenting myself with one thing—to earn a good dividend.

In connection with the above, we give, from *Light, Heat and Power*, the following brief description of the simple method used at the works of the Poughkeepsie (N. Y.) Gas Company, and which is the device of Engineer Tracy:

Unable to dispose of his tar at figures that were satisfactory, Engineer Tracy decided to burn it in the retort furnaces in place of coke, and after a number of experiments constructed a simple burner which operated successfully. The sectional cut shows the construction of the burner, which, by the way, was made entirely of ordinary iron pipe and fittings. The ¾ in. pipe, *a*, was connected to a tank, which was about 10 feet above the burner. In this case the tank was on top of the bench of retorts. A globe valve was put on the pipe, *a*, between the tank and the burner, at a convenient point, for the purpose of regulating the flow of tar to the burner. The pipe, *b*, diameter ¼ in., was connected to a boiler, from which the steam supply was drawn. Pipe, *d*, was used to draw off the water of condensation when starting the burner. One end of the steam pipe, *c*, was closed from ¼ in. to ⅛ in. in diameter, thereby forming a nozzle, as shown in cut.



The discharge pipe, *e*, was ¾ in. diameter and 18 in. in length, and was put through the brick front of the bench at a point about midway between the furnace bars and the bottoms of the lower retorts. A block of fire brick was placed at the rear end of the furnace to protect the back wall from the direct action of the flame, the heat of which was intense. The space in the furnace below the burner was nearly filled up with coke dust.

To obtain the best results, it was found necessary to have at the boiler a steam pressure of not less than forty pounds, and that the steam should be as dry as possible. The tar was run through a fine netting, to remove any dirt which might stop up the space around the steam pipe, *c*. The consumption of tar with this burner running continuously for twenty-four hours, connected to a bench of five retorts, no other fuel being used, was two and one-half barrels. During the above time the retorts were charged every four hours, and 6,000 pounds of coal were carbonized. The same work would require about forty bushels of coke when the burner was not used.

After being once properly regulated, and the tar and steam supply were kept constant, the burner required no more attention than a good injector. The combustion was so perfect no smoke could be observed escaping from the chimney.

The *Microscopical Journal* tells us that in order to draw pictures by means of the camera lucida without straining the eyes, it is necessary that the microscopical image and paper and easel be uniformly illuminated. If the image has, in comparison with the paper, too strong a light, the pencil will be seen with difficulty, if at all. On the contrary, if the paper, in comparison to the image, be too strongly illuminated, the delicate outlines of the latter will be indistinct. This difficulty may be remedied by throwing either the image or the paper into a shadow. Both may be done simply with the hand, or by a properly constructed screen of paper, or by a disk of pasteboard set up at some distance, and the like. A few trials with the microscope with different magnifications will afford the necessary experience for properly managing the light. In tracing the outlines of the image under the camera, the pencil used should not be too hard, and the lines should be very light.

[The Journal of the Society of Chemical Industry.]

[Continued from Supplement, No. 630, p. 10068.]

CHEMICAL AND ALLIED INDUSTRIES.*

By Watson Smith, Lecturer in Chemical Technology in the Victoria University, etc.

GROUP VIII.—METALLURGY.

The Abram Coal Co., Bickershaw, Wigan (No. 799).—This firm shows, among specimens of *gas coals*, the Abram new boghead cannel, giving gas of high illuminating power; selected cannel chippings, washed cannel nuts, and Arley gas coal. This latter coal gives gas of high illuminating power, and furnishes, it is said, a good yield of residual products. Specimens are also shown of Wigan 4 ft., 5 ft., and 6 ft. gas coals.

As regards *house coals*, there are the best Arley coal, one of the best house coals in the district; Orrell 5 ft. coal, and Abram main coal. These are raised from depths varying from 300 to 650 yards. A peculiarity with respect to the cannel is that it occurs in the *middle* of the Wigan 4 ft. mine, and is much thicker than at any other colliery in the district.

The Astley and Tyldesley Coal and Salt Co., limited, near Manchester (No. 813).—The specimens shown are blocks of the following: "Astley," best house coal; "Hartley," house and steam coal; "Six Feet Rams," steam coal; "Crombouke" coal; and Great Seven Feet coal.

The two latter blocks give sections of the upper part of the seams referred to, just as when taken from the mine at a depth of about 340 yds. from the surface.

Platt Brothers & Co., limited, Oldham (No. 806).—Specimens of "Big Mine" coal for house fire purposes, very clean and hot, with a minimum of ash. It is obtained from Moston Colliery, Failsworth, near Manchester. Calcined shale is also shown, for carriage drives, footpaths, and garden walks, as well as close fire bricks made from pit shale and clay ground together and passed through two pairs of rollers obtained from materials from the same colliery. Very good specimens of machine-made facing bricks and ornamental bricks are exhibited. Specimens of Mountain Mine coal, from the Jubilee Colliery, Shaw, near Oldham, are also shown: 1. For house fire purposes, slow burning and clean in use; 2, washed smithy coal for weldings; and 3, hard coke, made from Mountain Mine slacks, ground and washed, and containing carbon 93·23, sulphur 0·77, moisture 0·79, and ash 5·21 per cent.

Statistics of Coal Trade.

The approximate annual output of coal is about 160 million tons, and the value at the pits about 43 millions sterling. The output of coal reached its maximum in 1883, when the quantity raised was 163,737,000 tons. Since this date the amount raised each year has declined, that for 1885 (the most recent year for which statistics are available) being 159,351,418 tons, and it is said the quantity for 1886 will only be about 158,000,000 tons. The value has also decreased in the same period from about £45,000,000 to £42,500,000.

Percy C. Gilchrist, Palace Chambers, Bridge Street, Westminster, S. W.—The specimens exhibited illustrate the basic material used in the converter or open hearth furnace, the phosphoric pig used, the lime used during the process and the steel made, showing some of the uses to which it has been applied; finally, the slag, both as made and as ground ready for use as a manure.

Prior to 1879 it was believed that intense heat was the obstacle that prevented the elimination of phosphorus in the Bessemer and open hearth processes. The basic or Thomas Gilchrist process, introduced in 1879, proved that excellent steel could be commercially made from phosphoric pig by simply changing the lining in the converter and open hearth furnace from a silicious, *i. e.*, acid, one to a lime, *i. e.*, basic, one, and by adding some 2 cwt. to 4 cwt. of lime for each ton of pig treated. In other words, these processes, instead of being conducted so that the slag produced with the steel contained over 60 per cent. of silica and traces of lime, were conducted so that the slag produced contained, roughly, 6 per cent. of silica and 50 per cent. of lime and magnesia; under the former (acid) conditions the steel contained rather more phosphorus than the pig from which it was made: and under the new (basic) conditions the steel only contains 3 per cent. of the phosphorus in the pig treated.

The lime lining in general use is made by roasting or igniting limestone (preferably magnesian limestone) at a very intense heat, by which means the limestone becomes reduced in weight and bulk to one-half of its previous weight and bulk, and also becomes intensely hard. This material is ground and made plastic by admixture with boiled tar, and the resulting material put into place by ramming; or it is used in the form of bricks made under a very considerable pressure; the object of this basic lining being to allow of the production and retention of a lime (*i. e.*, basic) slag. The 2 cwt. to 4 cwt. of lime used per ton of pig treated consists of ordinary lime as free from silica as possible, the function being to produce a limey slag capable of absorbing the phosphoric acid produced by the oxidation of the phosphorus in the pig treated.

The pig used contains:

Silicon	0·2 to 1·5	per cent.
Sulphur	trace to 0·15	"
Phosphorus	0·08 to 3·2	"
Manganese	0·5 to 2·0	"

The steel made contains:

Silicon	trace.	
Sulphur	trace to 0·08 per cent.	
Phosphorus	0·002 to 0·08 "	
Manganese	0·1 to 0·5 "	
Carbon	0·08 to 0·5 "	as required.

The slag made contains 97 per cent. of the phosphorus in the pig treated, averaging:

Phosphoric acid	17 per cent. to 20 per cent.
Lime	50 "
Magnesia	4 "
Silica	8 "
Oxide of iron	14 "
Oxide of manganese	5 "
Alumina	2 "

This slag, ground to an almost impalpable powder, has been proved to be a valuable manure, giving the

* Report on Section III. of the Manchester Royal Jubilee Exhibition.

best results on sandy, peaty, and loamy soils, and is now becoming generally known as a valuable fertilizer.

The production of basic steel has been :

	England.	Other Countries.	Totals.
12 Months ending 30th Sept., 1878	20	—	20
" " " " 1879	1,150	50	1,200
" " " " 1880	10,000	40,000	50,000
" " " " 1881	46,120	289,880	336,000
" " " " 1882	109,364	340,636	450,000
" " " " 1883	122,380	511,993	634,373
" " " " 1884	179,000	685,000	864,000
" " " " 1885	145,707	799,610	945,317
" " " 31st Dec., 1886	277,259	1,097,758	1,375,017
	891,000	3,764,927	4,655,927

In 1886 some 1,650,000 tons of pig, scrap, and ferromanganese were employed; 171,000 tons of limestone for lining; and 240,600 tons of lime for additions—producing some 1,375,000 tons of ingots of the value of £4,125,000, and 412,500 tons of slag of the value of £412,500.

Before the introduction of this process one-tenth only of all the iron ores in Europe was available for steel-making, owing to their containing too much phosphorus, and owing to the fact that no phosphorus is eliminated in the processes of steel making then practiced. By this process the remaining nine-tenths can be made into excellent steel, the phosphorus at the same time being converted into a phosphate of lime, easily assimilated by plants.

The College of Agriculture, Downton, near Salisbury (No. 812), illustrates in a series of interesting specimens the experiments and researches of Dr. Munro on the utilization of basic slag for manurial purposes, as already referred to in the last named exhibit. A chart is shown indicating the effects of basic cinder used as a fertilizer. (See this *Journal*, 1886, pp. 104, 433, 464, 610, and 611.)

The Mostyn Coal and Iron Co., North Wales (No. 809), exhibits specimens of spiegeleisen, ferro-manganese, silico-spiegel, silicious iron, ferro-chromium, and also samples of manganese, while the West Cumberland Iron and Steel Co., limited (No. 811), shows specimens of material and products illustrative of the manufacture of Bessemer pig iron, steel rails, plates, and steel castings.

Messrs. Carrick & Brockbank, Pall Mall, Manchester (No. 730), show a beautiful model of Gjers, Mills & Co.'s Ayresome Iron Works, Middlesbrough, and a case containing samples of Ayresome foundry iron and hematite iron, with ferro-silicon and silico-spiegel.

Messrs. Johnson, Matthey & Co., Hatton Garden, London (No. 802).—Platinum in the form of apparatus for the concentration of sulphuric acid, etc., is shown to the value of £3,000. Glass is gradually giving way to platinum for the purpose of concentrating sulphuric acid. In German vitriol works these stills are of much more frequent occurrence than in English factories. Even in the comparatively small Swiss factory of Gebruder Schnorf, of Uetikon, near Zurich, referred to by Lunge in his book on the alkali manufacture as among the first to adopt Maletra's small kiln, there are two such platinum stills in operation. An interesting feature is the standard meter in irido-platinum, and of great value.

James Smith, 39 and 41 Bridge Street, Manchester (No. 803).—The process of manufacturing gold leaf is here seen in practical operation. In beating out the leaf a peculiar method of administering the blow with the mallet is necessary, one in which a certain forward movement of the whole body appears to be involved. This is one of the most popular exhibits in the section.

The Magnesium Metal Co., Patricroft, near Manchester (No. 804).—Prominent in this exhibit are very fine specimens of the ores of the metals antimony, bismuth, magnesium, mercury, potassium, sodium, vanadium, also silver and gold, with beautiful specimens of each of these metals. One of the ingots of antimony is perhaps the largest specimen ever exhibited. On its surface is distinctly seen the beautiful fern-like or "star" crystallization that characterizes this metal when pure; hence its technical name, "Star antimony." One of the specimens of bismuth shows the beautiful crystals, Grecian key-like in pattern, that characterize this peculiar metal. Magnesium is seen in the various forms in which it is produced for the market, such as ribbon, wire, ingots, and powder. Possibly the finest specimen of quicksilver ore existent in the world may be seen in this case. This magnesium company is the only firm in the kingdom which distills mercury from its ore or matrix. A fine specimen of metallic sodium is exhibited. Attention may also be called to the splendid exhibit of "silver cake," which weighs some 8,000 ounces, and to a valuable specimen of auriferous or gold quartz from the Sheba Reef, in the Transvaal.

The ore is found to average from five to seven ounces of gold to the ton. Immediately beneath this auriferous quartz may be seen a small bottle of pure gold, the actual product of one ton of this ore. Adjoining will be found some quartz in which the gold is visible. In addition to the precious metals, this firm exhibits a variety of chemicals. Among these we may mention sodium chlorate, crystallized; an article first introduced by the Magnesium Company, and which is now manufactured on a fairly large scale. Here also may be seen large specimens of salts of vanadium. The oxide of vanadium exhibited is a portion of the first specimen ever produced, and was shown a few years ago by Sir Henry Roscoe at a lecture delivered by him on "Vanadium" at the Royal Institution, London, as one of the greatest chemical novelties of that year. The specimens of senarmontite crystals, one of the oxides of the metal antimony, will be very interesting to mineralogists. The fine specimens of crystallized sodium and potassium have attracted much attention. With this firm, whose exhibits denote much skill and scientific enterprise, the name of its director, Mr. Samuel Mellor, is intimately connected.

Joseph Walker Parker & Co., Lead Works, Chester (No. 805).—This firm has long been noted for its sheet lead, termed "chemical lead," supplied to sulphuric acid manufacturers for their vitriol chambers. Red lead, and red lead for the use of glass makers; flake and powdered litharge, also flake litharge specially refined for varnish manufacturers; orange lead, and sublimed lead made from lead fumes, are represented. Laminated lead for damp walls, and all kinds of sheet lead; water piping, gas piping, lead pipe tinned inside, and pure and block tin pipe, offer considerable interest. Specimens of patent shot and hard shot, and also lead bullets, are shown. Special stress is laid on the dry white lead ground in oil, and the oval lead piping for resisting the action of frost.

Henry Wiggin & Co., 55 George Street, Birmingham (No. 810).—Specimens illustrating the manufacture of nickel and cobalt, from the raw material to the finished product, are shown. As raw materials, samples of nickeliferous pyrites from Norway, double silicates of nickel and magnesium from New Caledonia, arsenical nickel and cobalt from Hungary, and manganiferous cobalt ore from New Caledonia, are shown. The metals termed speiss or regulus, obtained in the smelting of these ores, and their ultimate solutions from which the iron, copper, etc., are separated by precipitation or otherwise, form an interesting feature. The nickel and cobalt are precipitated by a process applied by Mr. Chas. Askin, the originator of the firm, as hydrated oxides. The nickel oxide is then converted into metal for the manufacture of German silver and other white alloys, while the cobalt obtained in the form of various oxides is used for producing blues on earthenware, porcelain, and glass. Specimens of all these are shown, together with pure nickel oxide and metal in cubes and grains; also, an alloy containing respectively 50 per cent. of copper and of nickel, for casting purposes; and an ingot of German silver ready for rolling, as well as all kinds of utensils. Specimens of refined black cobalt oxide, cobaltous oxide, silicate of cobalt (printing blue), red silicate and carbonate of cobalt, and a handsome plaque illustrating the way in which various shades of cobalt may be produced upon china. Nickel and cobalt occurring in many complicated minerals containing sulphur, arsenic, iron, copper, antimony, bismuth, tin, lead, and various earthy matters, all of which require to be separated by smelting or wet processes. Various by-products obtained in these processes are exhibited. Among specialties in the form of white alloys is Wiggins' registered metal "silveroid," used largely for harness furniture, railway carriage fittings, steamship and lavatory fittings, etc. This alloy possesses the whiteness of silver, and does not become tarnished under ordinary conditions. The patent rolled nickel and cobalt, used especially for anodes in the processes of nickel and cobalt plating, and also a variety of cast and wrought anodes, are shown. As regards the ores, much of the nickel ore does not contain more than 2 per cent. of the metal, while the richest specimens obtained from Hungary are found with 15 per cent., and also 5 or 6 per cent. of cobalt. Nickel is at present very low in price—about 2s. per lb.; a few years ago it was as high as 16s per lb. The introduction of nickel as the means of whitening and coating copper has proved of the greatest value, and thus the extensive and important industry of electroplating with it has been built up.

Webster's Patent Aluminum Crown Metal Co., St. Mary Axe, London, E. C. (No. 807).—Aluminum is very light, and also capable of receiving a high polish; does not easily tarnish, and gives out a clear and beautiful ring when struck. It is, therefore, not surprising that inventors have paid it great attention. In the handsome showcase of this firm are exhibited articles illustrating the manufacture of aluminum and its alloys. As a raw material, a specimen of the chloride is shown, and also a large button of aluminum as reduced in the matrix in which it was formed; pure aluminum in pig, etc.; and various forms of alloys as applied to the requirements of the different industries.

Duncan McKechnie, St. Helen's, Lancashire (No. 808).—The wet process of copper extraction is here illustrated, and among the specimens of materials and products shown are Rio Tinto Spanish pyrites, burnt Spanish pyrites, purple ore, lead precipitate, silver precipitate, and copper precipitate. These are worked up to the production chiefly of refined ingot copper, refined bar silver, and pig lead, specimens of which are exhibited. The manufacture of sulphate of copper as a branch of the foregoing is illustrated as to material and product by specimens of argentiferous and auriferous shot copper, sulphuric acid, sulphate of copper, and silver residue.

Wet Process of Copper Extraction.—This process is used in the extraction of copper from the burnt cupreous pyrites used in the vitriol manufacture. The process, as worked, is generally designated Henderson's, but the idea was first worked out by Mr. Longmaid. In 1842 he took out a patent for "improvements in treating ores and minerals, and in obtaining various products therefrom, certain parts of which improvements are applicable to the manufacture of alkali." This consisted in calcining pyrites with sodium chloride at a low red heat, lixiviating, precipitating the copper with iron, and evaporating the liquor down to obtain crystals of sodium sulphate. This process was worked at St. Helen's for some time, but was abandoned in 1862. Mr. Henderson's process incorporated in a more or less modified form Longmaid's ideas, but to the former must be ascribed the credit of first recognizing the suitability of burnt Spanish pyrites for this method of treatment. Various kinds of furnaces have been in use in calcining the ore with sodium chloride. In Longmaid's process the ore was calcined in an open reverberatory furnace. There have also been employed long open furnaces fired by gas, furnaces in which an arch extended from the bridge half over the bed, thus protecting the ore nearest the bridge from too intense a heat. Mr. Gibb patented a mechanical furnace with revolving hearth, which was used at the Bede Metal Company's works, Newcastle-on-Tyne, but has a long time been abandoned, and now the furnace in general use since 1872 is the blind roaster, or muffle furnace.

The mixture of burnt ore and salt is calcined until the copper is converted into soluble cupric chloride. It is then lixiviated in vats containing about 14 tons of ore, with water alone, and later on with acidulated water, which removes the copper, silver, and lead, leaving the oxide of iron, called "purple ore," behind in the vat. The first three washes contain 95 per cent. of the silver, which is recovered by Claudet's process. In this process a precipitation with a soluble iodide is adopted. The resulting silver iodide is decomposed with zinc, and the zinc iodide then used to precipitate more silver. The silver precipitate obtained is smelted into argentiferous pig lead, which is then cupelled, and the silver cast into bars. The cupric liquor, after desilverization, is run into tanks containing scrap iron, and boiled until all the copper is precipitated as metallic copper. This, after washing and sieving, is either smelted and refined by itself, or along with the produce of other ores, into cake or ingot copper. The purple ore, or oxide of iron, is sold either in the fine state, for "fettling" puddling furnaces, or made into blocks for the blast furnaces. The lead precipitate is smelted in the Cornish furnace into pig lead.

Sulphate of Copper Manufacture.—This salt was at one time chiefly prepared as a by-product in silver smelting works. In argentiferous copper mattes obtained from these works the copper and silver were separated by means of sulphuric acid, the liquor obtained being run into leaden tanks, and copper sulphate crystallized therefrom. The silver and gold were left undissolved by the acid. Owing to the increasing demand for copper sulphate, and this source not being sufficiently productive, special works are now engaged in its manufacture.

Wet Copper Extraction.—Quantities of the above metals extracted in Great Britain during 1884, 1885, and 1886:

	Burnt Ore. Tons.	Metallic Cu extracted. Tons.	Extracted by Claudet's Process.	
			Gold. Ounces.	Silver. Ounces.
1884	416,412	15,200	1,900	335,000
1885	407,700	14,880	1,840	328,000
1886	393,699	13,799	1,780	316,928

About one-eighth part of this ore is treated at the exhibitor's works.

Sulphate of Copper.—The quantity manufactured is about 16,000 tons, of which about one-sixth is produced at the exhibitor's works.

GROUP IX.—ALKALIES, ACIDS, AND SALTS.

John Riley & Sons, Hapton Chemical Works, near Accrington (No. 814).—This firm makes a special feature of pure sulphuric acid produced from brimstone and concentrated in platinum. This pure acid is much in request for dissolving indigo, to form the sulphonic acid, as well as for the preparation of white and pure sulphate of ammonia.

A soda ash (Leblanc process), which has undergone special refinement for the purposes of the calico printer, is also a specialty. It is an article free from insoluble matter, iron, etc., and which can be used by bleachers without fear of iron stains, etc., in the cloth after bleaching, so detrimental to the colors used in printing and dyeing. In obtaining such a soda ash, besides special purifying processes, a system of mechanical furnaces, heated by coal gas, is adopted. For the wool scourers a pure and highly carbonated ash, free from hydrate, is made. Stannate of soda, made by Riley's patent process, and in a very pure state, is exhibited. It is used as a mordant by calico printers, dyers, etc. Ferrous sulphate ("copperas") as used in black dyeing and for preparing the indigo vat; and also ferrous and ferric chlorides, as used by dyers and paper makers. Copper sulphate and nitrate, tin crystals (crystallized stannous chloride), and also acetate and nitrate of tin, likewise serving as mordants, are exhibited, as prepared for mordanting purposes.

Zinc chloride is largely used by the Lancashire cotton merchants in the sizing of their goods, to prevent the starch of the size from contracting mildew. It is made in the pure state and liquid form for home consumption, but solid for export. Sulphate of zinc is also used for antiseptic purposes. Besides these, alizarin oil and oleine oils are specialties, as well as a series of chemicals made for the use of India rubber manufacturers, of whom there are a great many in the Manchester and Salford districts.

Gaskell, Deacon & Co. (No. 815).—The chief articles exhibited are bleaching powder, bicarbonate of soda, crystal carbonate, calcium chloride, soda ash of 30 per cent. and 58 per cent. of Na_2O, refined alkali at 30 and 58 per cent., cream caustic at 60 per cent., and white caustic at 60 and 70 per cent. Also a fine block of soda crystals under a glass shade.

Crystal Carbonate.—For an account of this valuable salt the reader is referred to the report on the chemical exhibits in the International Inventions Exhibition of 1885. (This *Journal*, 1885, p. 523.)

Bicarbonate of Soda.—From the crystal carbonate, itself a very pure article, a fine high strength bicarbonate is made which, on analysis, gives the following numbers: Bicarbonate of soda, 99·48; monocarbonate, 0·33; sulphate, *nil*; chloride, 0·05; magnesium chloride, *nil*; moisture, 0·10; insoluble, *nil*; total = 99·96.

The full account of the improved processes of manufacture patented by this firm will be found in Mr. Muspratt's address to the Society of Chemical Industry. (This *Journal*, vol. 5, p. 401; also vol. 4, pp. 523 and 524.)

Wigg Bros. & Steele, Old Quay, Runcorn (No. 817).—This firm exhibits specimens illustrating the manufacture of sulphuric and other acids, salt cake, copper by the wet process, pearl hardening, bleaching powder, and paints, with the raw materials used.

Messrs. Josias C. Gamble & Son, Gerrard's Bridge Chemical Works, St. Helen's (No. 819).—The name of Col. Gamble will always be closely associated with the history and development of the Leblanc alkali industry. It was in the works of this firm that Weldon first discovered the true conditions on which depends the success of the Weldon process for recovering peroxide of manganese from the otherwise waste still liquors.

Besides the usual products of the alkali maker in an alkali-making district, this firm shows the following specialties of interest:

Sulphide of sodium, in crystals, and of the formula $Na_2S + 9H_2O$, made by Schaffner and Helbig's patent process, pure chlorate of sodium, made by Pechiney's patent process, the same in small crystals, pure chlorate of barium in crystals, and of the formula $Ba(ClO_3)_2 + H_2O$, barium chlorate (pure) in powder, chlorate of strontium (pure) $Sr(ClO_3)_2$, sodium hypochlorite $NaClO$, potassium hypochlorite $KClO$, aluminum hypochlorite

$Al_2(ClO)_6$, chloric acid $HClO_3$, calcium chlorate $Ca(ClO_3)_2$, ammonium chlorate NH_4ClO_3, aluminum chlorate $Al_2(ClO_3)_6$, pearl hardening.

Tennants & Co., Mill Street, Clayton, Manchester (No. 818).—Like most of the alkali makers in the Manchester district, this firm has grafted on to the usual products of the Leblanc alkali industry those used by the dyer, calico printer and bleacher. Since it may be interesting to other alkali makers not resident in a district the prevailing industries of which are so largely those devoted to dyeing and calico printing, the list of exhibits shown by Tennants & Co. is given:

Iron.	Tin.	Sodium.	Potassium.	Zinc.
Ferrous chloride	Stannate of soda	Sodium bisulphite	(Acid potassium sulphate)	Zinc chloride
Ferric chloride	Stannous chloride (tin crystals)	Sodium sulphate (Glauber's salt)	(Potassium bichromate)	Zinc sulphate
Ferrous sulphate	Stannic chloride	Sodium bichromate (dry)	Red and yellow prussiates of potash	—
Ferric sulphate	Tin nitromuriate	Sodium bichromate (crystals)	—	—
—	Tin oxymuriate	—	—	—
—	Tin acetate	—	—	—

Magnesium.	Manganese.	Copper.	Acids.	Calcium.
Magnesium sulphate (Epsoms)	Precipitated pure peroxide of manganese	Copper sulphate	Rectified oil of vitriol	Calcium bisulphate
Magnesium carbonate	Manganese chloride	Copper nitrate	Brown oil of vitriol	—
Magnesite	Manganese carbonate	—	Hydrochloric acid	—
—	—	—	Aquafortis (com.)	—
—	—	—	Aquafortis (pure)	—

James Muspratt & Sons, Liverpool and Widnes (No. 820).—James Muspratt was the founder of the South Lancashire alkali industry, and any exhibition of chemical products would be incomplete without being represented by so historic a firm.

The specialties illustrated in the examples shown are sulphur recovered from alkali waste by Mond's process, manganate of soda, chlorates of potash and soda produced by Messrs. Muspratt and Eschellmann's process, together with the materials and by-products. (See this *Journal*, 1885, p. 524.)

Barium Products.—Barium sulphide, zinc sulphide, blanc fixe, barium chloride and hydrate.

A. G. Kurtz & Co., Sutton Alkali Works, St. Helen's, Lancashire (No. 825).—The manufactures of this old established firm are chiefly confined to salt cake designed for alkali and glass making, caustic soda, chlorate of potash, bleaching powder, soda ash, and soda crystals.

The Widnes Alkali Co., limited, Widnes, Lancashire (No. 830).—*Articles Exhibited.*—Caustic soda, 76, 74, 72, 70, 64, and 60 per cent. white; chlorate of potash in crystals, containing 99·98 per cent. of $KClO_3$, and extra fine ground; chlorate of calcium in solution; manganate of soda, the new disinfectant; permanganate of soda, crude and in solution; black ash or crude carbonate of soda; sulphate of soda (salt cake); bleaching powder.

GENERAL STATISTICS OF THE ABOVE PRODUCTS OF THE ALKALI MANUFACTURER.

The manufacture of caustic soda has increased within the last twenty-two years from about 100 tons per week to about 3,000 tons per week.

Caustic Soda is chiefly used by paper makers, and in the manufacture of soap; but it has also a considerable application for various other purposes. Its selling value in 1865 was £13 per ton for 60 per cent., in 1873 £22 to £24, and the price has now declined to £7 per ton.

Manganate of Soda has been recently developed on a manufacturing scale for the deodorization of sewage, and as a disinfectant.

The total weights of caustic soda and bleaching powder made for the year 1886 were:

Caustic Soda: 153,884 tons.

Bleaching Powder: 136,234 tons.

The return of the exports to foreign countries for the year 1886 was:

Alkali, including caustic soda, soda ash, bicarbonate, crystals, etc.: 284,684 tons, at a value of £1,609,484.

Bleaching Powder: 77,524 tons, value £503,000

The annual consumption of raw materials for the above, which merely include the two chief export centers, and two articles out of the numerous products of the alkali trade, will be about:

1,423,465 tons of fuel.
394,742 " " pyrites.
713,112 " " salt.
284,493 " " lime.
134,849 " " limestone.

The trade also employs some thousands of workpeople, and a surrounding of dependent trades for machinery, packages, etc.

The value of chemicals (with the exception of bleaching powder, which is supported by a combination of manufacturers) has been reduced about one half during the last ten years.

The Greenbank Alkali Works Co., limited, St. Helen's, Lancashire (No. 831).—This firm acquired many years ago a high reputation, both in this country, the Continent, and America, for a very pure and high strength caustic soda, and it was, the writer believes, the first to put in the market a 76 per cent. caustic soda. The improvements introduced into the various processes which mainly led to the production of this high strength caustic, as well as increased yields of chlorate of a superior quality, in the operations involved in that branch of manufacture, were mainly the work of the late Mr. W. H. Balmain, the former manager, whose name is historically connected with the development and improvement of the Leblanc soda industry in South Lancashire.

The specialties exhibited may be enumerated as doubly refined caustic soda, and the same in powdered form for bleachers, dyers, etc., and for making hard soap; pure caustic potash for woolen manufacturers, and for making pure potash soaps; refined pearlashes; chlorate of potash in crystal and powder; bleaching powder; pure red oxide of iron and oxide paint.

John Thom, Birkacre, Chorley, Lancashire (No. 821).—This exhibit is of great historic interest, being a faithful representation in model form of the simple apparatus which Mr. John Thom, now for many years a citizen of Manchester, though originally hailing from the neighborhood of Glasgow, constructed in 1836 for making soda by the ammonia process. Mr. Thom was the original discoverer of the simple reaction between sesquicarbonate or otherwise bicarbonate of ammonia and sodium chloride, which forms the essential principle of the ammonia soda process. He was the first who made paraffin wax as a commercial article, obtaining the paraffin, however, from wood tar by Reichenbach's process. He made small candles with this paraffin so obtained. Moreover, Mr. Thom was the first to manufacture artificial manures, containing ammoniacal salts; he was actually the founder of the artificial manure industry. This work was accomplished in a chemical factory at Camlachie, near Glasgow, belonging to Messrs. Turnbull and Ramsay, in whose service he then occupied the position of chemist, at the not too liberal salary of £30 per annum.

We have already referred to the fact that Dalton impressed penny ink pots and soda water bottles into his service in the pursuit of scientific research, but he was outdone by Thom in point of economy, the latter illustrating the reaction between sodium chloride and ammonium sesquicarbonate in apparatus simply composed of the hollow in the palm of one hand, using the finger of the other as a stirrer. I will use Mr. Thom's own words in a letter to his son: "My first experiment was made by taking a good pinch of the substances (bicarbonate of ammonia and common salt), placing them in the palm of my left hand, mixing them with the forefinger of the right hand, and allowing water to drop from the fingers of my right hand to wash with as little water as possible.

"The heat of my hand dried very soon the product, and I learned that the decomposition could be made, whether profitable or not. This experiment done in the same way was shown by me to Professor Graham, the late Dr. Young, and many others, among whom I may mention Mr. Williiam Henderson, of Glasgow—then a pupil of Graham's. After ascertaining that soda could be made in that way, I tried it in increasing quantities. I had no machinery in connection with it, except and old screw-press (model shown). I mixed the two salts in tubs (see models) and then placed the product in the till or burnt clay moulds, then used for refining or refined sugars. Later on, we substituted wooden ones of a similar shape, but larger. The soda was not crystallized by itself, but was dissolved with soda from other processes and crystallized in 500 gallon pans. It was considered better to carry this product from the ammonia soda process than put up dissolving, crystallizing, and draining apparatus specially for it." This latter statement, of course, means that so impure a soda would not bear the expenses alone of a sufficient purification, and hence it was mixed with the liquors of a stronger and purer Leblanc soda, and converted into soda crystals, relying upon the fact of formation of these crystals from a tolerably dilute solution, and the retention in the mother liquors of the salt in excess and sal-ammoniac. The writer has received from Mr. William Henderson, of Glasgow, complete confirmation of Mr. Thom's statements, and he (Mr. Henderson) describes not only the experiments wrought in the palm of Mr. Thom's hand, but the apparatus for making larger quantities of the crude ammonia soda.

The following clause in a letter from Mr. Thom to the writer is worth quoting: "When I left my employers," writes Mr. Thom, "I informed them that I did not think it advisable for them to continue this process, unless they got a chemist or some one who would feel interested in its success. I left them because I did not get paid enough. I had £30 a year for, I think, four years, and the attention required through bad joints, etc., etc., was very great. I left in 1838." Those, therefore, who feel disposed to institute any comparison between John Thom and Dyar and Hemming, to the disadvantage of the former, should reflect on the fearful disadvantages of Thom's situation, and that despite all these he still succeeded in passing from his crude laboratory performances to his equally crude manufacturing operations, and did succeed in putting ammonia soda in the market.

Some may be curious to know in what spirit he left such not very liberal employers. The account of the final epioside deserves recital; it redounds to his credit, as it doubtless did to theirs—in quite another sense! As it was resolved to stop the process when Thom left, he "collected all the odds and ends with ammonia in them," to use his own words, "mixed them and all the urine on hand, with the charred siftings—that is, the charcoal not salable from being too small and with a lot of old animal charcoal which we had from the 'yellow prussiate' process and 'red liquor bottoms'—*i. e.*, the sulphate of lime resulting from making the 'red liquor' or aluminous mordant for calico printing. I took enough of the latter to at least fix all the ammonia in the lot. These were mixed in large heaps, many scores of tons, and I advised my employers to sell all as fertilizers. This mixture was tried in the Vale of Leven, Scotland, and in the West Indies, for sugar cane, by James Ewing, then M.P. for Glasgow. The result was astonishingly successful. Mr. Turnbull came up to Manchester to see how the stuff had been made, and tried to get me to go back to make more. I advised him to obtain slaughter house offal, dead horses or cattle dying of disease, and place this material in a chamber where uncondensed muriatic acid gas could pass through, and continue the purchase of urine of the neighborhood (previously the material, bought at 3d. per ten gallons, for the ammonia soda process) along with the red liquor bottoms. He followed my instructions more or less, and laid the foundation of a most lucrative trade to him, and I believe, and the late Dr. R. Angus Smith believed, of the first manure works, of which there are now so many."

Messrs. Brunner, Mond & Co., limited, Northwich, Cheshire (No. 816).—The description and general report given of the exhibit of this firm in the late Inventions Exhibition of 1885 (see this *Journal*, 1885, pp. 526 and 527) may be very well referred to in this case, with the statement that this exhibit in Manchester is, as regards specimens, show case, and general appearance, incomparably finer than that in London. The specimens illustrate the Solvay ammonia soda process, with the improvements introduced by Mr. Mond and other members of the firm. A specimen of bleaching powder made by Mond's recently patented process is now to be seen (this *Journal*, 1887, p. 140), as also one of caustic soda, and another of a beautifully crystallized sesquicarbonate of soda, made by the process of Watts and Richards. This salt, which is crystallized in fine needles, is not a true sesquicarbonate, but has the formula $Na_2CO_3.NaHCO_3.2H_2O$. A great advantage of this salt is that it does not effloresce or deliquesce. It is readily soluble in water, and is free from insoluble matter. The writer understands that this salt has already been tried in Bradford for wool washing with most satisfactory results. It is said to serve in the washing of flannels without shrinking them.

Messrs. Bell Brothers, limited, Middlesbrough (No. 822), exhibit specimens illustrating the character of the salt deposits and the salt industry of the Tees; also the Schlosing ammonia soda process. Samples illustrating the manufacture of pig iron at the Clarence Iron Works, near Middlesbrough, and also the manufacture of barium compounds, on the Tyne.

The Eureka Salt Manufacturing Co., limited, Northwich, Cheshire (No. 836).—Rock salt, natural brine, and manufactured salt. A fine bust of Queen Victoria in manufactured salt forms a conspicuous object in this exhibit.

John Howarth Padgett, Brookdale Salt Works, Northwich, Cheshire (No. 826).—Various qualities and brands of salt.

R. & J. Garroway, Netherfield Chemical Works, Glasgow (No. 832).—An interesting model of the Netherfield chemical works, and fine specimens illustrating the sulphuric, nitric, acetic, boric, oxalic, and hydrochloric acid manufactures; as also the manufacture of mordants and other dyers' and printers' chemicals.

Messrs. Peter Spence & Sons, Manchester Alum Works, Manchester (No. 829).—The leading feature of this exhibit is a colossal block of alum standing 12½ ft. high, measuring 6 ft. in diameter, and weighing slightly over 10 tons. This is the largest block of crystallized alum which has ever been manufactured, and has an imposing appearance, the color being exceedingly white; the light transmitted through the mass, when looked at from the hollow inside, is of a beautiful pale blue tint.

In the case standing alongside the block there is a rich variety of manufactured products.

One pile is composed of blocks of "turkey red" alum manufactured by the firm. This alum is employed by all the great turkey red dyers, and is the purest which has ever been produced on so large a scale. Specimens of ground alum and granulated alum, and a collection of splendid alum octohedra, are exhibited.

The sulphate of ammonia is manufactured by Messrs. Spence's patented process, and is of extremely pure quality.

The column of light brown material is alumino-ferric cake, an article patented by Messrs. Spence a number of years ago, and is used very extensively in sizing ordinary classes of paper, also in the clarifying of water for towns and manufactories. The article is now employed in almost every part of the world for one or other of these purposes.

"*Alfersil*" is the new sewage precipitant lately introduced by this firm, and is used for the purification by precipitation of refuse waters from manufactories and town sewage. It is claimed as the cheapest known source of soluble alumina for this purpose.

Specimens of sulphate of ammonia and sulphate of potash.

A bottle containing a liquid representing the average tint of Manchester sewage is shown. A second is a sample of Manchester sewage after purification by the *alfersil* above referred to, the result being a very pure effluent obtained at an insignificant cost. The small bottle by the side of this contains the impurities precipitated from one gallon of this sewage. A third bottle represents the average tint of the water of the river Irwell. A fourth the same water after purification by alumino-ferric. This is the quality of water with which the ship canal will be supplied when all the manufacturers in the district purify their refuse water. The small bottle alongside the last contains the impurities precipitated from one gallon of Irwell water.

Of the two 2 ft. tubes, the first shows Manchester water as drawn from the mains of the exhibition. The second contains the same water purified with Messrs. Spence's alumino-ferric cake, used in the proportion of one ton to twenty million gallons. A comparison of these will show to what a degree of purity towns' water supplies can be brought by the use of those materials. Few people have examined perfectly pure water in the analyst's 2 ft. tube, and the lovely blue tint of this purified product is very striking. It may be noted that the water after treatment with alumino-ferric contains no constituent which it did not contain before.

The other exhibits are sulphuric acid, manufactured from Spanish pyrites, and sulphuric acid from the spent oxide of gas works.

It is now nearly half a century since Messrs. Spence

commenced the manufacture of alum in the neighborhood of Manchester, and the name of the firm is now universally associated with alum and aluminous products of the best quality.

The firm also exhibits a set of the new international hydrometer devised by Mr. Frank Spence as a standard measure both of the strength and specific gravity of solutions and other liquids, and proposed by him in replacement of the arbitrary and incommensurate hydrometric scales in use in Great Britian, the Continent, and America. Mr. Spence's object is to unify the hydrometric scales of all nations. His hydrometer possesses the unique advantage of showing at a glance both the strength and specific gravity of a solution.

R. & N. Pott, 22 Southwark Bridge Road, London (No. 827).—All the vinegars exhibited are brewed from grain only. *Brown vinegars:* These are in their pure state as brewed. *Pale vinegars:* These are the same as brown vinegar, but reduced in color by being blended with pure distilled vinegar. *Concentrated vinegars:* These are produced by an improved patented process of fractional distillation, whereby all empyreumatic and foreign flavors are expelled, leaving nothing but a pure concentrated vinegar. *Distilled vinegars.* These differ only from the concentrated vinegar in the strength, the distillation not having been carried to so high a point. Samples of grain used in the manufacture of vinegar. Samples of rape seed used as a filtering medium. Models of vat, showing the new process of acetifying patented by the exhibitors, illustrating the advantages over the old process and apparatus (of which latter there is also a model). Model of vat, showing method of cleansing and clarifying the vinegar by filtration through rape seed. Models of casks used in the trade.

In Concannon's History of Southwark mention is made of the vinegar works of Messrs. Pott as existing in the year 1641.

W. G. Pursell & Co., 13 Bernard Street, Leith (No. 833).—Borax in various forms suitable for manufacturing, chemical, therapeutic, and domestic purposes. Refined boric acid, and a specially prepared powder for the preservation of fresh fish and other articles of food.

The exhibitors refer to the statement of an Italian physician to the effect that the workpeople in borax factories appear to be safe-guarded from the attacks of cholera. During the terrible epidemic of 1864-65 the workmen in seven contiguous factories in Italy were quite free from the disease, which killed one third of the population of a village in the immediate vicinity. He recommends the internal administration of borax as a specific for cholera, in doses of five grammes per diem. He believes that it destroys not only the microbes in the intestinal canal, but also in the blood.

The trustees of the late James Buckley, 108 Higher Ardwick, Manchester (No. 834).—Crystallized ferrous sulphate (copperas), largely used, especially in black dyeing, ink manufacture, and for the reduction of the indigo vat, and other purposes.

J. M. Collett & Co., High Orchard Works, Gloucester (No. 823).—Specimens of pure bisulphites of lime, soda, potash, and magnesia, and also of the sulphites of lime, potash, and soda. Solutions of sulphurous acid and a sulphite composition called the "Universal Preservative." Samples of isinglass from Russia, Siberia, Hudson's Bay, Brazil, West Indies, Penang, Bombay, Kurrachee, China, and Manila.

C. B. Cullerne & Co., Crown Works, Napier Street, Liverpool (No. 824).—Samples of isinglass, finings, bisulphite of lime, sulphurous acid, etc.

Anthony K. Kaye & Son, Mold Green Chemical Works, Huddersfield (No. 828), exhibit specimens of a variety of dye stuffs, mordants, soaps, dyewoods, dyewood extracts, and general drysalteries.

H. D. Pochin & Co., limited, Quay Street, Salford (No. 835).—*Aluminous Cake.* Mr. Pochin, previous to 1884, undertook a series of experiments for the purpose of obtaining a concentrated sulphate of alumina, which he succeeded in doing in 1854 by the decomposition of kaolin. This process was patented in 1855. The quantity consumed in the first year was only a few hundred tons, but before the patent expired the sale had increased to very many thousands of tons per annum of his own manufacture, besides a quantity made by other persons under a royalty paid to him. This article (aluminous cake) is very largely used by paper makers.

Sulphate of Alumina is produced from aluminous cake, this being much cheaper than by employing the old process, which consisted in precipitating the iron from the very crude sulphate of alumina by means of ferrocyanide of potassium. This article is used in the manufacture of tissue papers and the finest kinds of writing papers.

Concentrated Alum.—A neutral sulphate of alumina of a low price, which may be advantageously employed for paper sizing and the precipitation of waters containing sewage and other flocculent matter. This article contains 14 per cent. of alumina, and will compare favorably with any alumina compound now in the market at an equal price. The results are not equal to those obtained by the use of aluminous cake, but they are satisfactory to those who prefer a neutral sulphate.

It is perhaps desirable to explain here that all paper would be blotting paper unless it was made partially waterproof by precipitating with the pulp, in the process of manufacture, resin obtained from a resin soap, and then mixing with either aluminous cake or sulphate of alumina—the waterproofing material consisting, in the aluminous cake, of hydrated silica, alumina, and resin; and in the case of sulphate of alumina, of resin and alumina alone.

China Clay.—This article, which is the raw material for the aluminous cake and sulphate of alumina, is found in very large quantities in Cornwall, and results from the decomposition of feldspar in granite. It is in its natural condition pipe clay, but as made artificially is a very pure silicate of alumina. Messrs. Pochin are among the largest manufacturers in Cornwall, the production and sale amounting to tens of thousands of tons per annum. It is also used in pottery, and is one of the best articles used for stiffening and finishing cloth.

Binarseniate of Soda as used by calico printers as a dung substitute.

Dextrin has been made by this firm since the year 1830.

Acetate of Alumina obtained by a new process, which has been in operation for the past two and a half years. It is free from color and from excess of acid.

The *Refined Resin* exhibited is the result of the patent taken out by Messrs. Hunt and Pochin. By this patent common black resin is distilled by superheated steam and deprived completely of its coloring matter.

Patent Anhydrous Resin Size.—This size is prepared for use with Pochin's patent aluminous cake, and is quite free from water. When used in the following proportions, the greatest economical results are obtained—there is no loss of size on the one hand or aluminous cake on the other. The result, we think, has in very few cases been obtained by paper makers, previous to the introduction of this size. It is now obtained with certainty, if used in the following proportions: To 5 lb. of the size, 7 lb. of aluminous cake. The best way of proceeding is to dissolve the size in water, in the proportion of say 3 lb. to one gallon of water, boil it for about 15 or 20 minutes, *so as to insure complete solution;* it is then fit for use.

In the Irish section, Messrs. Harrington Brothers, of the Shandon Chemical Works, Cork, exhibit a variety of preparations, comprising oxides for the glass, porcelain, and enamel industries, such as cobalt, nickel, copper, tin, and other oxides. Besides these are metallic tungsten and its salts, stannate of soda, oxalate of antimony, penta and tri chlorides of phosphorus, golden sulphide of antimony, etc. A series of organic preparations is also shown, as well as one of chemically pure salts for analytical and scientific purposes, and finally a set of pharmaceutical preparations. This enterprising firm publishes an exceedingly neat price list in the form of a small book, which excels even those supplied by well known firms in Germany. This serves not only as a price list, but as a pocket-book, since it contains most of the usual tables, such as those of the atomic weights, specific gravities, and percentage strengths of acids and alkalies, alcohol tables, with other useful data.

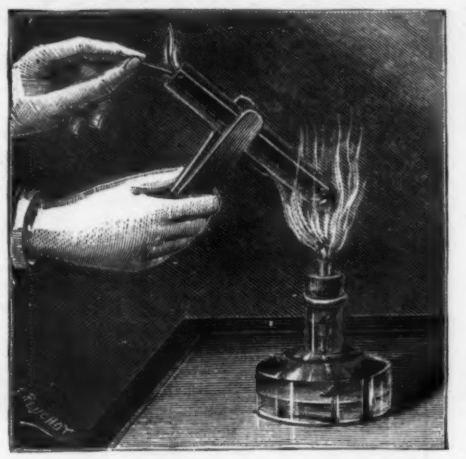


FIG. 1.—PREPARATION OF OXYGEN WITH A LAMP MADE OF AN INKSTAND.

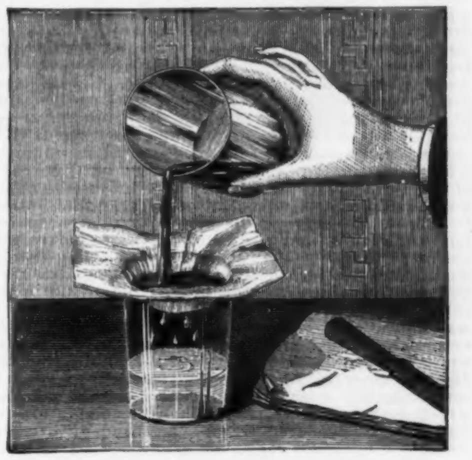


FIG. 2.—A SIMPLE FILTER.

CHEMISTRY FOR AMATEURS.

WE have already published numerous notes on physics without apparatus, and the experiments that we have described have always been received with favor. It has been possible for us to pass in review all branches of physics.

What we have done for physics we are going to undertake for chemistry, for the study of which it is sometimes necessary to have recourse to apparatus; but we shall never describe any apparatus but simple, easily constructed, and practical ones. In this way we hope to render services to our young readers, and sometimes also to their teachers, even. We may recall the fact that for many years chemistry was our first profession, and we take pleasure in recalling the time spent in laboratory manipulations.

We in nowise make a pretense of giving a course in chemistry, but simply intend to describe the means of easily performing classical experiments with elementary material. For example, suppose it is desired to show the properties of a burning gas, and to light a nearly extinct match in oxygen; it is only necessary to heat a mixture of fused chlorate of potash and binoxide of manganese in a glass tube (Fig. 1). But, in order to heat this tube, we must have a spirit lamp. This we shall make out of an inkstand. We fix a cork in the neck of the latter and make a round hole through it with a rat-tail file. In this hole we insert a copper tube which we obtain from a cheap penholder, and through the tube we pass a wick. Finally, we fill our bottle with alcohol, and now have a lamp that will render us very frequent services.

Fig. 2 shows the manner of obtaining a filter for separating a precipitate from the liquid in which it has been formed. A simple piece of blotting paper placed upon a tumbler will serve as a filter, provided we pour the liquid to be filtered in small quantities and with precaution. As an example of a precipitate, we may take the formation of chromate of lead. We pour into a glass a dilute solution of chromate of potash; it is transparent and of a light yellow color. Upon adding to this liquid a small quantity of sugar of lead, we at once obtain a dark yellow, grumous, very thick precipitate of insoluble chromate of lead, which may be separated by filtering.

The blowpipe is one of the apparatus indispensable to the chemist. He has to use it constantly for increasing the calorific action of a flame by blowing air into it.

Fig. 3 shows an operator who has converted a clay pipe into an excellent blowpipe, by means of which he produces a tongue of fire with the flame of a candle. At the extremity of the flame he is letting fall some iron filings, which become incandescent, burn, and oxidize under the action of the elevated temperature. This is a pretty experiment to perform upon the combustion of divided iron in the air.—*La Nature.*

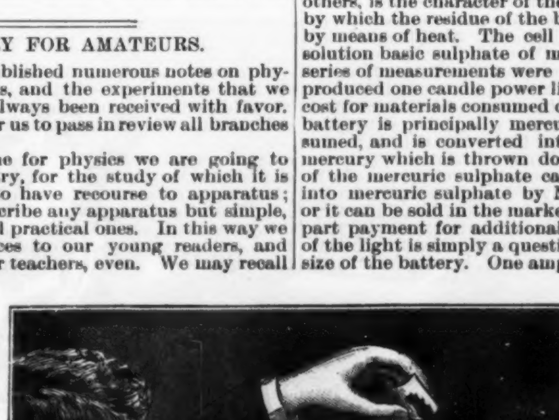


FIG. 3.—A SIMPLE BLOWPIPE.

THE SCHANSCHIEFF BATTERY.

FROM a report by Mr. W. H. Preece, F.R.S., on Mr. Schanschieff's primary bateries, it appears that the peculiar novelty of the cell, which distinguishes it from others, is the character of the solution, and the means by which the residue of the battery can be recuperated by means of heat. The cell is a zinc carbon, and the solution basic sulphate of mercury. A very accurate series of measurements were made with a lamp which produced one candle power light for eight hours, at a cost for materials consumed of 1d. The residue of this battery is principally mercury, but zinc is also consumed, and is converted into sulphate of zinc. The mercury which is thrown down by the decomposition of the mercuric sulphate can either be reconstructed into mercuric sulphate by Mr. Schanschieff's process or it can be sold in the market or taken in exchange in part payment for additional solution. The duration of the light is simply a question of the lamp and the size of the battery. One ampere flowing for one hour requires about 1 oz. of mercuric solution per cell Given a cetain lamp to burn a certain number of hours, the size of the battery to maintain it alight is very simply calculated. The battery has a high electromotive force and very low internal resistance. It is highly efficient, is a constant cell, showing almost entire freedom from polarization; it is eminently adapted for portable lighting, miners' lamps, and many other purposes; no gas, or smell, is given off from the battery either when at work or at rest; it is as easily charged by an ordinary workman without risk of failure as an existing lamp is filled. The four-cell miner's lamp

weighs only 5 lb., and can be kept for any length of time ready for use, without any consumption of materials or loss of energy. It will cost for lighting, taking everything into consideration, about one penny per shift.

THE NEW PHONOGRAPH.

TEN years ago a young man came into the office of the SCIENTIFIC AMERICAN, and placed before the editors a small, very simple machine about which very few preliminary remarks were offered. Our visitor without any ceremony whatever turned the crank, and to the astonishment of all present the machine said: "Good morning. How do you do? How do you like the phonograph?" The machine thus spoke for itself, and made known the fact that it was the phonograph, an instrument about which much was said and written, although little was known.

It was the latest invention of Edison, and the editors and employes of the SCIENTIFIC AMERICAN formed the first public audience to which it addressed itself. The young man was Mr. Thomas A. Edison, even then a well known and successful inventor. The invention was novel, original, and apparently destined to find immediate application to hundreds of uses. Every one wanted to hear the wonderful talking machine, and at once a modified form of the original phonograph was brought out and shown everywhere, amusing thousands upon thousands; but it did not by any means fulfill the requirements of the inventor. It was scarcely more than a scientific curiosity or an amusing toy. Edison, however, recognized the fact that it contained the elements of a successful talking machine, and thoroughly believed it was destined to become far more useful than curious or amusing. He contended that it would be a faithful stenographer, reproducing not only the words of the speaker, but the quality and inflections of his voice; and that letters instead of being written would be talked. He believed that the words of great statesmen and divines would be handed down to future generations; that the voices of the world's prima donnas would be stored and preserved, so that, long after their decease, their songs could be heard. These and many other things were expected of the phonograph. It was, however, doomed to a period of silence. It remained a toy and nothing more until a few months since, when it was made known to the public that the ideal phonograph had been constructed; that it was unmistakably a good talker, and that the machine which most people believed to have reached its growth had after all been refined and improved until it was capable of faithfully reproducing every word, syllable, vowel, consonant, aspirate, and sounds of every kind.

During the dormancy of the phonograph its inventor secured both world-wide fame and a colossal fortune by means of his electric light and other well known inventions. He has recently devoted much time to the phonograph, and has not only perfected the instrument itself, but has established a factory provided with special tools for its manufacture, in which phonographs are to be turned out in large numbers, with interchangeable parts.

In general, in the early phonographs, it was necessary that the listener should hear the sounds uttered into the receiving mouthpiece of the phonograph to positively understand the words uttered by the instrument.

In the later instruments, such as were exhibited throughout the country and the world, the same difficulty obtained, and perfection of articulation was sacrificed to volume of sound. This was necessary, as the instruments were exhibited before large audiences, where, it goes without saying, the instrument, to be entertaining, had to be heard. These instruments had but one mouthpiece and one diaphragm, which answered the double purpose of receiving the sound and of giving it out again. Strangely enough, the recently improved phonograph is more like the original one

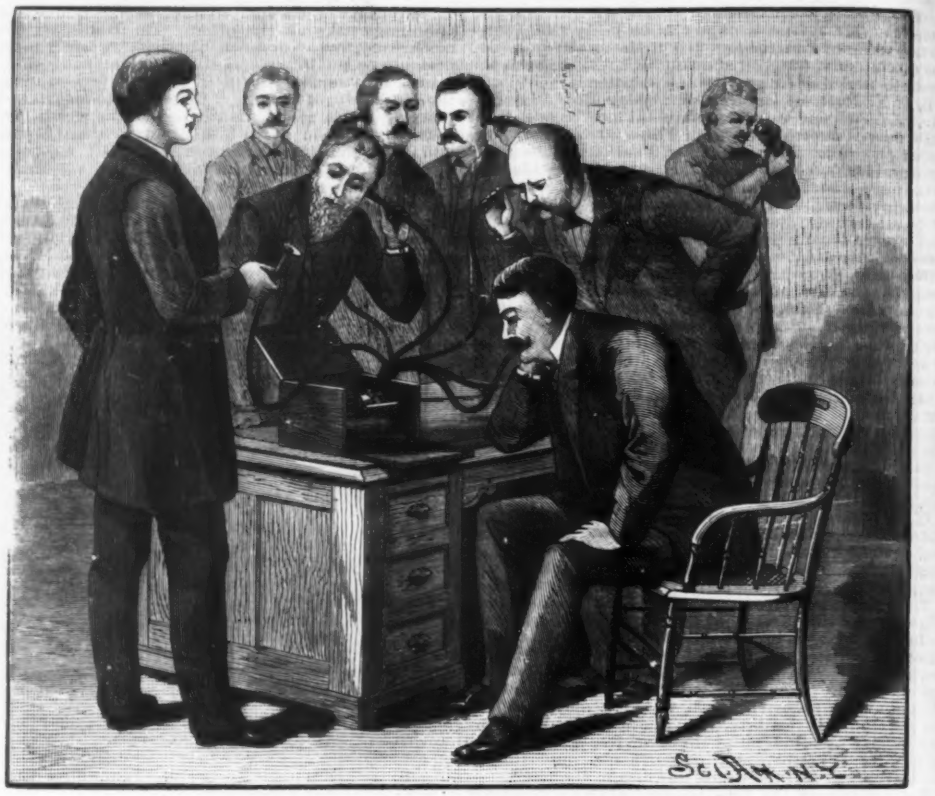


FIG. 1.—NEW PHONOGRAPH WITH MULTIPLE EARPIECE.

than any of the others. It is provided with two mouthpieces, one for receiving and one for speaking.

The new phonograph, which forms the subject of the larger illustration, is of about the size of an ordinary sewing machine. In its construction, it is something like a very small engine lathe; the main spindle is threaded between its bearings, and is prolonged at one end to receive the hardened wax cylinder upon which the sound record is made. Behind the spindle and the cylinder is a rod upon which is arranged a slide, having at one end an arm adapted to engage the screw of the spindle, and at the opposite end an arm carrying a pivoted head, provided with two diaphragms, whose positions may be instantly interchanged when desirable. One of these diaphragms is turned into the position of use when it is desired to talk to the phonograph, and when the speech is to be reproduced, the other diaphragm takes its place. The diaphragm which receives the speech and makes the impressions upon the cylinder is shown at 3 in one of the small cuts. The needle by which the impressions are made in the wax is attached to the center of the diaphragm and pivotally connected to a spring arm attached to the side of the diaphragm cell. The device by which the speech is reproduced is shown in section at 4. The cell contains a delicate diaphragm of gold beater's skin, to the center of which is secured a stud connected with a small curved steel wire, one end of which is attached to the diaphragm cell. The spindle of the phonograph is rotated regularly by an electric motor in the base of the machine, which is driven by a current from one or two cells of battery. The motor is provided with a sensitive governor which causes it to maintain a very uniform speed. Motion is

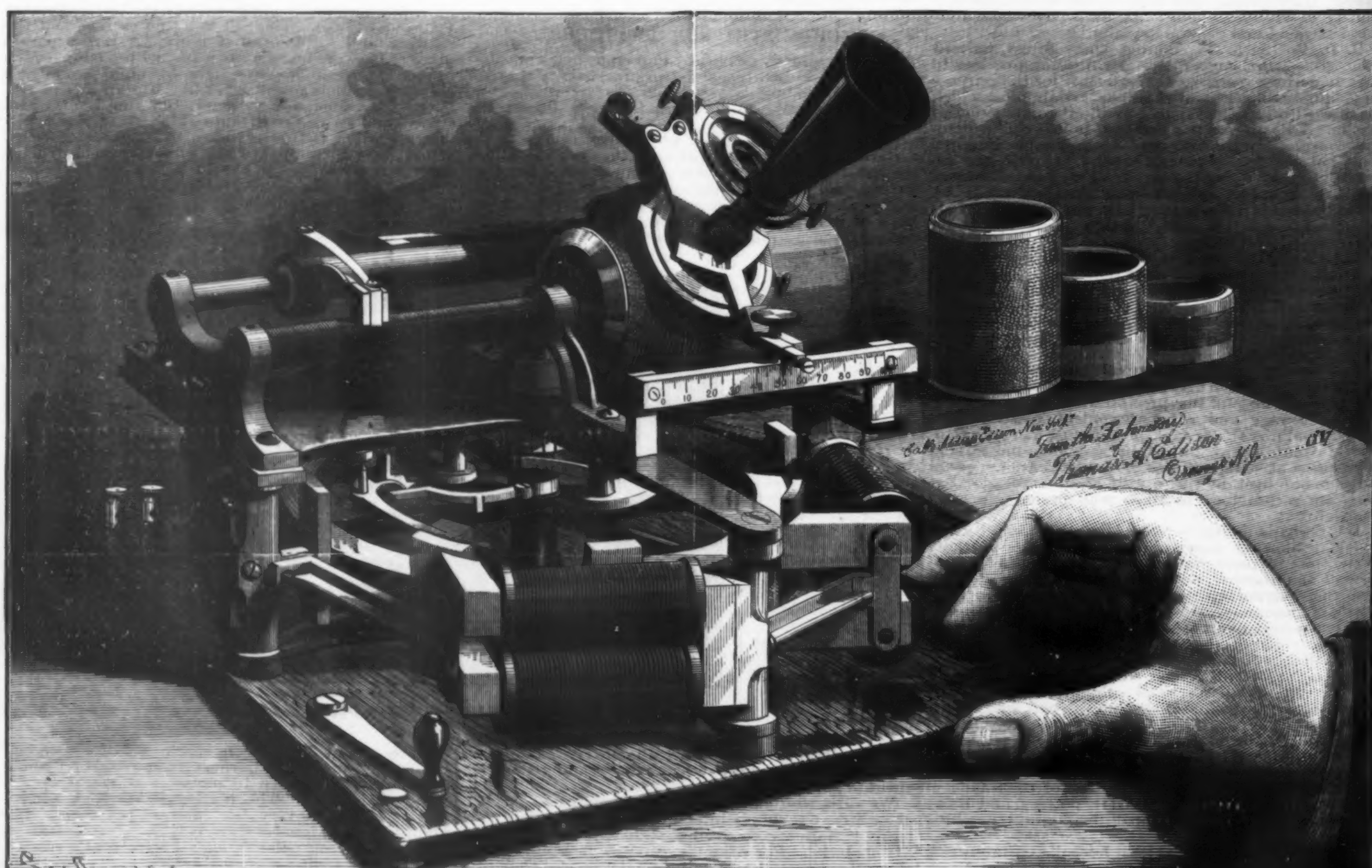


FIG. 2.—EDISON'S NEW PHONOGRAPH.

transmitted from the motor to the spindle by beveled friction wheels. The arm which carries the diaphragms is provided with a turning tool for smoothing the wax cylinder preparatory to receiving the sound record.

The first operation in the use of the machine is to bring the turning tool into action and cause it to traverse the cylinder. The turning tool is then thrown out, the carriage bearing the diaphragms is returned to the position of starting, the receiving diaphragm is placed in the position of use, and as the wax cylinder revolves, the diaphragm is vibrated by the sound waves, thus moving the needle so as to cause it to cut into the wax cylinder and produce indentations which correspond to the movements of the diaphragm. After the record is made, the carriage is again returned to the point of starting, the receiving diaphragm is replaced by the speaking diaphragm, and the carriage is again moved forward by the screw, as the cylinder revolves,

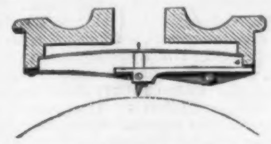


FIG. 3.—RECEIVING DIAPHRAGM.

causing the point of the speaking diaphragm to traverse the path made by the recording needle. As the point of the curved wire attached to the diaphragm follows the indentations of the wax cylinder, the speaking diaphragm is made to vibrate in a manner similar to that of the receiving diaphragm, thereby faithfully reproducing the sounds uttered into the receiving mouthpiece.

A crucial test of the capabilities of this machine was recently made in our presence at Edison's laboratory, near Llewellyn Park, Orange, N. J. A paragraph from the morning newspaper was read to the machine in our absence, and when upon our return to the instrument it was reproduced phonographically, every word was distinctly understood, although the names, localities, and the circumstances mentioned in the article were entirely new and strange to us. Another test of the perfection of the machine was the perfect reproduction of whistling and whispering, all the imperfections of tone, the half tones and modulations even, being faithfully reproduced. The perfect performance of the new instrument depends upon its mechanical perfection—upon the regularity of its speed, the susceptibility of

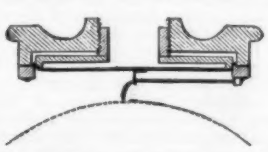


FIG. 4.—SPEAKING DIAPHRAGM.

the wax cylinder to the impressions of the needle, and to the delicacy of the speaking diaphragm. No attempt is made in this instrument to secure loud speaking—distinct articulation and perfect intonation have been the principal ends sought.

A highly magnified section of the phonograph cylinder, showing the indentations, is illustrated; A representing a section of the face of the cylinder, B a transverse section of a portion of the cylindrical wax shell, and C showing a less magnified face view of a small portion of the cylinder.

To give an idea of the number of vibrations required in making a phonographic record we have given in Fig. 7 a copy of the record of the word "Hello!" which is reproduced by the aid of a tracing point connected with a delicate mirror arranged to reflect a light spot upon a moving strip of paper, as seen in Fig. 8, the path of the light spot having been traced by a pencil in the hand of a careful operator.

The new phonograph is to be used for taking dictation, for taking testimony in court, for reporting speeches, for the reproduction of vocal music, for teach-

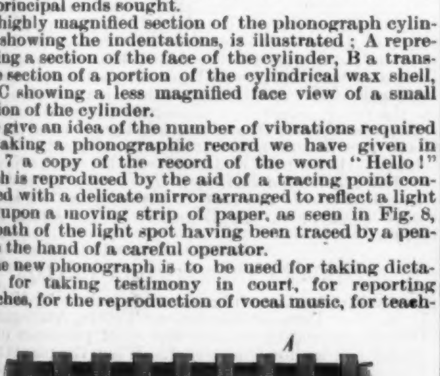


FIG. 5.—PHONOGRAPHIC RECORD MAGNIFIED.

ing languages, for correspondence, for civil and military orders, for reading to the sick in hospitals, and for various other purposes too numerous to mention.

Imagine a lawyer dictating his brief to one of these little machines; he may talk as rapidly as he chooses, every word and syllable will be caught upon the delicate wax cylinder, and after his brief is complete he may transfer the wax cylinder to the phonograph of a copyist, who may listen to the words of the phonograph and write out the manuscript. The instrument may be stopped and started at pleasure, and if any portion of the speech is not understood by the transcriber, it may be repeated as often as necessary.

In a similar manner a compositor may set his type directly from the dictation of the machine, without the necessity of "copy," as it is now known.

Mr. Edison informs us that the whole of "Nicholas Nickleby" could be recorded upon four cylinders each 4 inches in diameter and 8 inches long, so that one of these instruments in a private circle or in a hospital could be made to read a book to a number of persons. The multiple earpiece by which this is accomplished is shown in one of our engravings.

The little wax cylinders upon which the record is made are provided with a rigid backing, and the cylinders are made in different lengths; the shortest—1 inch long—having a capacity of 200 words, the next in size 400 words, and so on. These cylinders are very light, and a mailing case has been devised which will admit of mailing the cylinders as readily as letters are now mailed. The recipient of the cylinder will place it on his own phonograph and listen to the phonogram—in which he will not only get the sense of the words of the sender, but will recognize his expression, which will of course have much to do with the interpretation of the true meaning of the sender of the phonogram.

A very interesting and popular use of the phonograph will be the distribution of the songs of great singers, sermons, and speeches, the words of great men and women, music of many parts, the voices of animals, etc., so that the owner of a phonograph may enjoy these things with little expense.

It may even be pressed into the detective service and used as an unimpeachable witness. It will have but one story to tell, and cross examination cannot confuse it.

Extensive preparations for the manufacture of the phonograph have been made, and it is probable that within a short time these instruments will be as common and as indispensable as the sewing machine or the type writer.

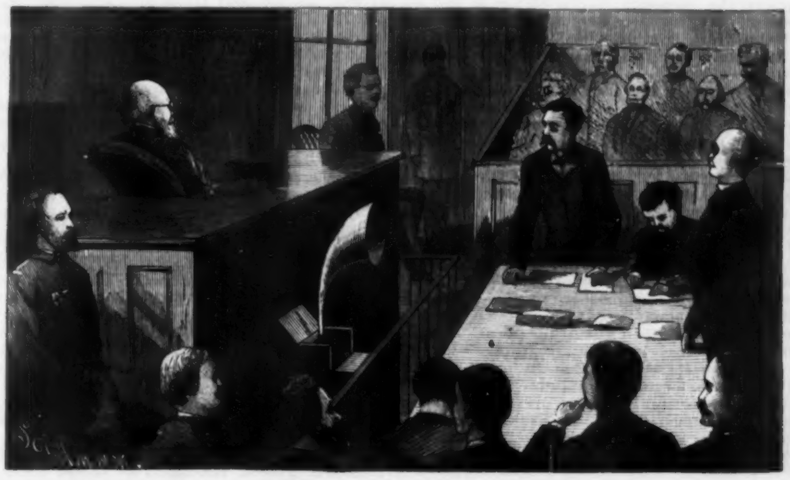


FIG. 6.—THE PHONOGRAPH IN COURT.

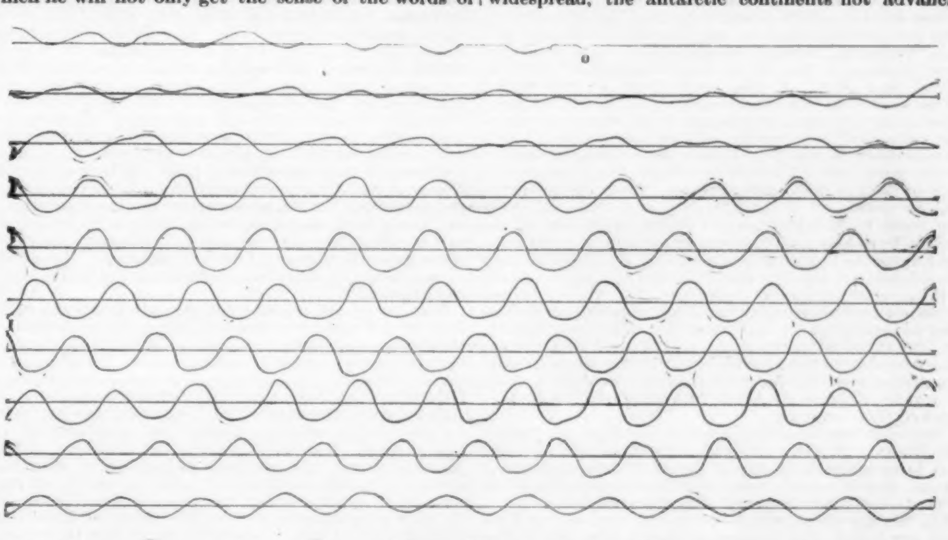


FIG. 7.—ENLARGED TRACING OF THE PHONOGRAPHIC RECORD OF THE WORD "HELLO."

GLACIAL EPOCHS AND THEIR PERIODICITY.*

By ADOLPHE D'ASSIER.

THE diluvium is met with throughout the entire southern zone as well as on the mountains of the temperate regions of the northern hemisphere. It is found again in the southern hemisphere, but not so widespread, the antarctic continents not advancing much toward the south, and offering less area than those of the north. Its composition varies according as it had its origin in the ancient glaciers or in ancient watercourses. In the former case, which is that of the country of mountains, such as the Alps and Pyrenees, it exhibits all the characters of the deposits formed by the glaciers of the present time. It is this similitude that has caused the true nature of the

* Continued from SUPPLEMENT, No. 631, page 10084.

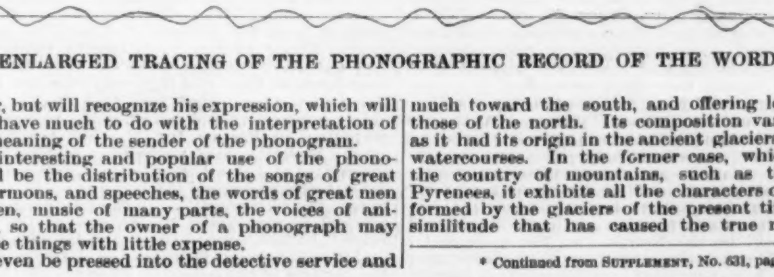


FIG. 8.—APPARATUS FOR TRACING THE PHONOGRAPHIC RECORD.

diluvium to be recognized. Let us imagine a series of moraines rising by stages from terrace to terrace and becoming smaller and smaller, resting upon a bed of gravel and formed of a mixture of pebbles, sand, clay, and erratic blocks mixed pell-mell without apparent order. At the foot of the mountains, where the moraines stop, and mark the limit of extension of the ancient glaciers, the deposits that continue to the sea change physiognomy, for they here arise from another cause—the fall of rain. Let us, with Mr. De Lapparent, recall the fact that the prime cause of glacial epochs was abundant precipitations of water which a temperature higher than that of our day, and consequently a much more active evaporation of the seas, continuously brought to the surface of the continents. This enormous mass of vapor fell as snow upon the high summits and as diluvium rain in the valleys. The watercourses that these rains fed, uniting with the torrents derived from the glaciers, converted them into immense rivers, which deposited a thick sediment in the plains. Here, more erratic bowlders, more moraines, and upon the bed of gravel that forms the base of the quaternary rest thick strata of pebbles, sand and earth, covered with a layer of ferruginous clay called *lehm* or *loess*, according as it is of a dark brown or of a yellowish brown, that is to say, according as it has been more or less oxidized in contact with the atmosphere. North America, enjoying a mean temperature lower than that of Europe, doubtless because of the trade winds that blow over its east coast and of the polar currents that wash it, is the classic land of diluvium. This latter occupies an area of over eight million square miles, and reaches the 39th parallel, thus extending about two degrees beyond the latitude of New York. Certain erratic blocks in making their way south have traveled 900 miles. In Northern Europe, heated by the Gulf Stream and counter trade winds, the deposits do not extend beyond the 37th parallel. They form a long tract extending from the North Sea to the Oural. Starting from the mountains of Sweden and Finland, the erratic blocks have stopped at 600 miles from the point of departure. They, as well as the moraines, reappear in the mountains of Central Europe, such as the Alps and the Pyrenees.

The glaciers that tourists go to visit in the valleys of Switzerland are a continuation, upon a small scale, of those of former times. Every year, they are observed to increase in autumn and winter, in consequence of the fall of snow, to slide under the action of gravity along the sides of the mountains that they excavate, to deposit here and there erratic blocks of granite, detached from the high summits by frost or lightning, to stop and partially melt in the course of summer, and then to recede, leaving beneath them, as a token of their passage, a line of moraine formed of pebbles, gravel, and clay. At the same time, a small watercourse makes its exit from beneath the field of ice, and, after opening a passage through the moraine, traverses the valley and runs to the sea or neighboring river. The glaciers of the first quaternary times proceeded in the same way. They differed from those of our day only in their gigantic proportions. Their former existence is proved by the polishing of the rocks that project from high escarpments; by the huge size of the erratic bowlders (some of which measure several hundred cubic feet), the altitude of the place where they were deposited, and the length of their journey; by the still greater distance traversed by the terminal moraines and their immense development, which has long caused them to be taken for hills; and, finally, by the extraordinary discharge of the watercourses that issued from the glaciers—vast rivers whose mouths usually (at least during great freshets) reached a width of several miles, as shown by the alluvial deposits that marked their passage.

The most remarkable glacier of the Alps was that of the Rhone. It extended over more than two hundred and forty miles, from upper Valois to the environs of Lyons, and at certain points of its course had a thickness of nearly five thousand five hundred feet.

On the Pyrenees, which are not so high as the Alps, and are nearer the tropics, glacial action was not so greatly developed. The most extensive fields of *neves* did not exceed 42 miles in length, and terminated at an altitude of 1,300 feet. The Pique glacier, which was one of the largest, had a thickness of 2,950 feet at Luchon. On the side toward Spain, they were still more reduced in extent and thickness, and their lower extremity never descended below an altitude of 2,950 feet.

If the periodical passage of the perihelion to the summer solstice every 21,000 years leads to the return to our hemisphere of great circumpolar winters, it follows that glacial action must have manifested itself several times during the quaternary era. This is confirmed by observation. Three periods of cold and abundant falls of snow, proved by as many deposits lying one over another and sometimes separated by formations of lignite, have been recognized at a number of points, especially in the Bavarian plain and in certain valleys of the Alps and Pyrenees. As the last passage of the perihelion to the winter solstice occurred in the year 1250 of our era, this date marks at once the middle of the glacial epoch now impending over the austral hemisphere, the end of the most recent one that the boreal hemisphere has witnessed, and the beginning of the new one that we have just entered, and which will be the fourth. As the cycle of the period is 21,000 years, the beginnings of the three great winters that have prevailed over the north of Europe, Asia, and North America correspond, then, to the years 19750, 40750, and 61750 before our era. We know not whether the antarctic glaciers preceded or followed the arctic. The first supposition appears to us to be the most probable, since the bed of pebbles upon which the diluvium rests seems to indicate that the advent of the glaciers was posterior (in the northern hemisphere) to that of quaternary times. If this was the case, the beginnings of the four austral glacial epochs would correspond to the dates 9250, 30250, 51250, and 72250 before our era. The time that has elapsed from the end of the pliocene up to our day may be estimated, then, as about 70,000 years.

I have above stated that, with the exception of the displacement of the perihelion, all the factors of glacial action vary in the course of ages. Now, the four principal ones—the eccentricity of the earth's orbit, the obliquity of the ecliptic, the evaporation of the seas, and the altitude of mountains—have constantly and perceptibly diminished since the dawn of the quaternary epoch, and this decreasing progression will continue for a long time to come.

The three circumpolar winters that have succeeded one another in our hemisphere have necessarily followed an analogous course, and this, moreover, is confirmed by observation. In fact, the deposits of the first period advanced further toward the south than those of the second, and those of the second, in their turn, exhibit a greater development than those of the third, which, in a number of localities, are so circumscribed that they have hitherto passed unnoticed. We may therefore lay it down as a principle that the fourth glacial epoch, on which we entered in the year 1250 of our era, will possess but insignificant proportions as compared with those of its predecessors. Europe will not again see that immense winding sheet of snow which, at the beginning of quaternary times, covered its northern zone and the mountains of temperate regions for ages, and the fears that at first prevailed on the subject of our great capitals, Berlin, Vienna, Paris, London, and New York, were groundless.

The polar ice will doubtless encroach upon St. Petersburg and Stockholm, but the other cities mentioned will not be reached. The retreat of the living world toward the south will in all probability be reduced to a movement of a hundred leagues, perhaps less. As an offset, immense virgin forests in the antarctic hemisphere will be offered to human activity, as the character of the austral ice is to recede toward the pole in measure as that of the north advances.

From the present position of the perihelion on the ecliptic, we have seen that the last great boreal winter had its maximum of intensity in the year 9250 before our era and ended in 1250 of our era. The periodical return of glacial epochs every 21,000 years would be a demonstrated fact could we verify one or the other of these dates experimentally. We think that both are capable of verification—the first with sufficient approximation and the second in the precisest manner. Let us first take up the most ancient date. We know that prehistoric man, following the receding movement of the glaciers, took possession of various points of Central Europe in measure as vegetable mould reappeared, that is to say, as the white sheet that covered it receded toward the north or to the summits of the mountains. The date of his arrival in these localities must therefore have been posterior, by a certain number of centuries, to that of the greatest extension of glaciers. This is confirmed by observation. It has been established, in fact, by the researches of archeologists that the most ancient vestiges of man, found in lacustrine habitations or turf pits, date back to an epoch separated from us by from 70 to 80 centuries. These figures result from a comparison of various means furnished by localities whose superficial strata contained Roman coins that served as a chronological datum point. Let us mention certain peat marshes of Denmark explored under the auspices of the Society of Antiquaries of the North, the alluviums of the same, profoundly studied by Mr. Marcelin, etc. Estimating the interval that separates us from the Roman occupation at about fifteen centuries, it has been found possible to calculate the time necessary for the formation of the strata corresponding to the ages of polished and carved stone, and fix the age of the most ancient of these deposits at about 7,000 or 8,000 years. This figure agrees perfectly with the slowness of the movement of the glaciers.

Now let us cast a glance at the physiognomy exhibited by the climate of Central Europe at the decline of the last glacial epoch, as well as at the modifications that it has undergone in modern times. The documents are not wanting, and it is easy to assure ourselves, by following them from age to age, that the middle of the 13th century (the date of the passage of the perihelion to the winter solstice) marks but the end of one glacial epoch and the beginning of another. All the historians and geographers of antiquity who have spoken of Gaul and Germany agree in saying of these countries, especially of the second, that, before the Roman conquest, they were the lands of hoar frost. The climate of Gaul recalled that of the Germany of to-day, and the climate of Germany that of Sweden. Tacitus, in his book on the customs of the Germans, asserts that one could not get used to so cold, so foggy, and so inclement a climate unless born in it.

The temperature gradually became milder up to the 13th century, and this meteorological fact has been attributed to the clearing away of the trees. We cannot accept this view, while admitting the climatic influence exerted by forests, since the latter have not ceased to diminish, both in France and Germany, up to the present time, and yet the temperature of these countries, instead of continuing to rise, has lowered very perceptibly since the end of the Middle Ages, judging from the retreat of vegetation toward the south. These secular variations in temperature are very naturally explainable on the supposition that the hoar frosts of Gaul and Germany were the last echo of the glacial epoch that had just ended. The alternately progressive and retrogressive movement of the grapevine in France for the last twenty centuries gives a high degree of probability to this theory. On the arrival of Julius Cæsar in Gaul, this valuable plant did not extend beyond the latitude of Bourges, that is to say, the 47th parallel. In the following centuries, it reached in succession the valleys of the Loire and Seine. In fact, toward the end of the 13th century, we find it cultivated at Orleans, and, later on, at Paris, in the gardens of the palace of Thermes inhabited by the Emperor Julian, where it grew in company with the fig tree. Two hundred years afterward we find it in Normandy. In the 8th century it extended over all the north of France, from the coast of Brittany to the Rhine, which it had crossed. It kept prospering for a few hundred years more, but, toward the end of the 13th century, a receding movement, which still continues, began to manifest itself. We know that the grape does not now ripen to the north of Paris nor upon the sides of certain mountains of the center of France where it was formerly cultivated. Other plants have followed the grapevine in its retrogressive movement toward the south or toward the plain. The chestnut tree has ceased to prosper on the high plateaux of Ætna. The sugar cane has disappeared from Provence. In lower Languedoc the olive and orange tree have receded several miles toward the Mediterranean. On the Pyrenees, Alps, Carpathians, etc., the upper border of the forests of firs is decreasing in altitude from century to century. It may be said, in a general way, that from the latitudes of Sicily, perhaps even from Northern Africa to Spitzbergen, vegetation has experienced a time of arrest or of recession from the end of the 13th century to our day. This impoverishment of vegetable forces can be attributed only to the progressive lowering of the temperature—a fact that has been established, moreover, in various countries by thermometric observations. All the old persons of Toulouse state that fifty years ago grapes were gathered two or three weeks earlier than they are to-day, that summer clothing was put on on the Thursday before Easter, and that on that day the young girls went to church in white muslin frocks. Explorations of the arctic regions have led to the same conclusions. It has been ascertained by navigators that since a few hundred years the ice of the poles has resumed its journey toward the south. Certain dales of Greenland, which were inhabited at the beginning of the 14th century, have had to be abandoned since then in consequence of the encroachment of the snow. An analogous cooling has been observed in Iceland. The island of Jean Mayen is to-day inaccessible to ships, a formidable barrier of ice defending the approaches to it. Do not all these proofs of diverse origin demonstrate that since the middle of the 13th century (that is, since the last passage of the perihelion to the winter solstice) the north of Europe has entered upon a new glacial cycle, whose thermic effects, unperceived up to the present by the unlearned, have not escaped the experienced eye of the geologist, the botanist, and the physicist?

Let us now proceed to the southern hemisphere and cast a glance at the glaciers of this region, in order to compare them with those of the northern hemisphere. We know that the characters of these latter are their apparition at the beginning of the quaternary epoch, their periodical return, and the constant diminution in the extent and volume of their deposits. If the antarctic glaciers exhibit the same characters, and if, moreover, they alternate with the preceding, it is allowable to conclude that the periodicity of the great circumpolar winters is a demonstrated truth. Now all the facts collected up to the present tend to establish a perfect concordance in the progress of the glacial phenomena of the two hemispheres. First and foremost, their alternation cannot be doubted, for it is easy to assure ourselves that the austral regions are to-day undergoing the vicissitudes of a glacial epoch. On another hand, in fact, geographers teach us that the white cap that surrounds the south pole extends over an area of nine million square miles, while that of the north pole is now reduced to a third of these figures. On another hand, it has been found that at an equal latitude the temperature of the regions in the vicinity of the south pole is generally lower than in arctic countries. The similitude of the ages, of the periodicity, and of the mode of formation of the deposits, too, is confirmed by observation, as is proved by the following passage borrowed from Haast, the learned explorer of the glaciers of New Zealand: "The fields of snow and the glaciers of the southern Alps of New Zealand, as compared with those of Europe, have much greater dimensions, especially if the difference in altitudes be taken into account. The lines of the lakes on the two sides of this chain and the huge moraines which mark the entrance limits of the extension of the post-pliocene glaciers, among other signs, show us obviously that these glaciers anciently possessed still greater dimensions. And yet, prior to the formation of the post-pliocene glaciers with so well marked limits of extension, the glacial phenomenon must have occurred in this country upon a much vaster scale."

As may be seen, the precision of the antarctic glaciers recalls that of the arctic ones in every point, thus giving a new degree of certainty to the theory that I have just set forth, and which presents itself as the simplest and most rational one that has hitherto been proposed. The periodicity of epochs of cold and their alternation in the two hemispheres, according to an astronomical cycle of long period, are, I think, an acquired truth. I have tried to sketch the broad lines of this phenomenon, characteristic of the quaternary epoch, with the aid of evidence collected during a half century, leaving to future explorers the care of lighting up the still obscure sides of it.—*A. D'Assier, in La Revue Scientifique.*

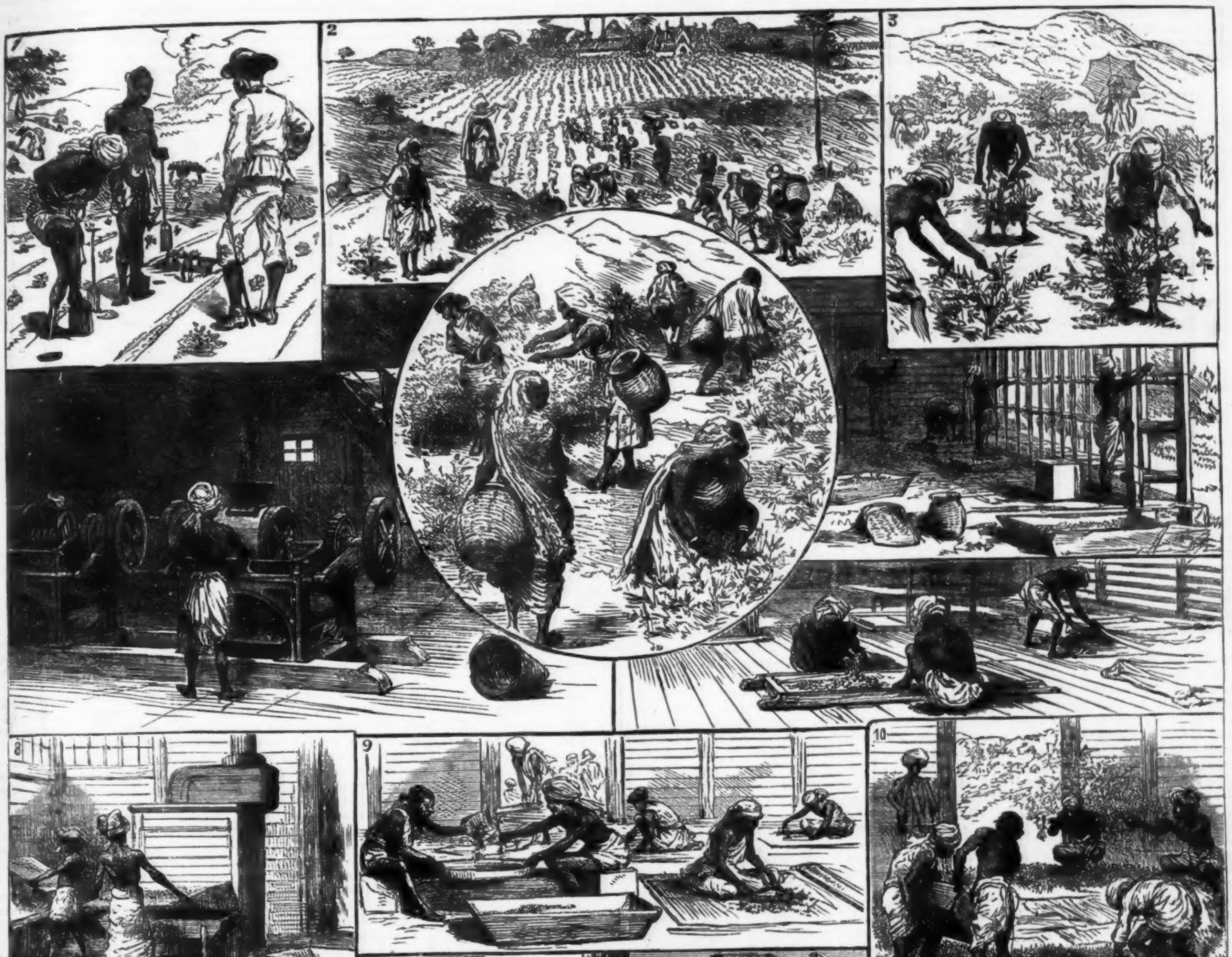
THE TEA INDUSTRY IN CEYLON.

OUR illustrations, from sketches taken by Mr. John L. K. Van Dort, at Blackstone Estate, Ambegamowa District, represent some of the chief processes of preparing the tea for the market. When the plants arrive at maturity, they are pruned and almost denuded of leaves. From the shoots which follow only the tender leaves are plucked—the bud with the half developed leaf and the one next it. These are called "flush," and after manufacture are known as Orange Pekoe, Broken Pekoe, Pekoe, Pekoe Souchong, and Souchong, according to the quality of the leaf. Women and children pick the leaves, which are withered in lofts, and then rolled by machinery—the rolling breaking the shells and twisting the leaves. They are now left to ferment in trays, and then fired and dried in a "sirocco," or drier. This is the last process, the tea being finally packed, and dispatched to the railway station in bullock carts. The laborers on tea estates, with the exception of a few Singhalese carpenters, are Tamils from Southern India. In the sketch of the roll call the manager's dwelling house and the factory are shown, with Adam's Peak in the distance. The monkish looking figures in cowls are laborers, with their blankets folded over their heads as a protection against the cold of the morning. The itinerant tea vender is a Tamil, and his customers Singhalese.—*London Graphic.*

PHYSIOLOGICAL STUDY OF THE HUMAN VOICE.

IN a report recently presented to the Institute upon the physiological studies made on the human voice by Mr. Piltan, and applied by him to the teaching of singing, our eminent composer, Mr. Saint Saens, expresses himself thus:

"Singing masters, in general, are not physiologists, and their methods, whatever be the results of them, are purely empirical. They sometimes teach their pupils that certain sounds must start from the chest and others from the head, etc. Strange to say, the pupils perfectly comprehend these incomprehensible



1. Planter and Transplanter
2. Roll Call at Blackstone Estate, Ambegamowa District
3. Pruning
4. Picking Flush
5. Rolling
6. Withering
7. Fermenting
8. Drying
9. Sifting and Sorting
10. Bulking.
11. Packing
12. Despatching by Cart
13. At the Railway Station.

THE TEA INDUSTRY IN CEYLON.

things, and thus often become excellent singers. But this consideration cannot arrest the research for truth."

It will be seen from this how much the learned academician approves of Mr. Piltan's studies, as is his custom, moreover, to encourage everything based upon truly scientific data.

Mr. Piltan has taken an average of the pulmonary capacity of a large number of singers, both male and female. He remarks that the greatest number of cubic inches of air introduced into the lungs does not correspond to the best voice, and that the pressure of such air is minimum in good singers. The pressure of a fine voice ought not to reach that of an organ. He makes the very important remark, too, that the motions of the glottis, far from being voluntary, obey reflex motions, that is to say, the vocal cords are submitted to the respiratory motions, just as are the tongue and uvula, for example, and rise of themselves at an inspiration, and undergo the reverse motion at an expiration.

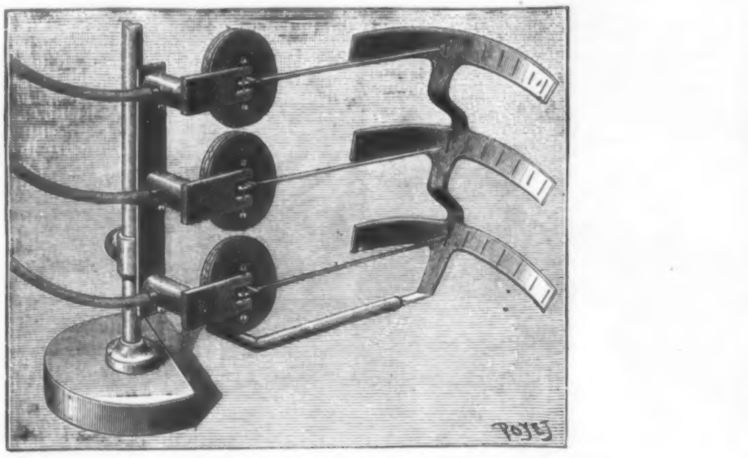


FIG. 1.—PILTAN'S APPARATUS FOR STUDYING THE VOICE.

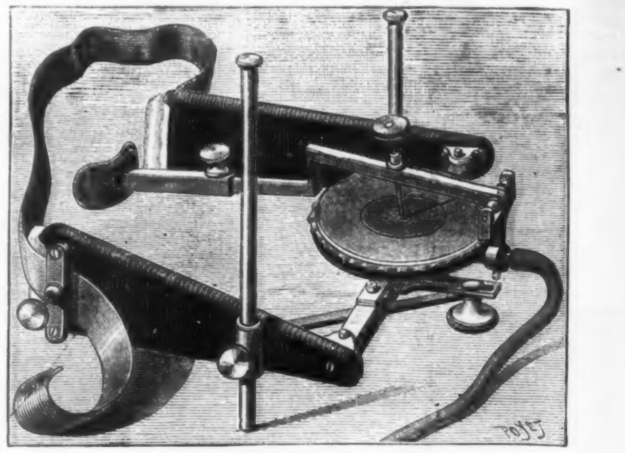


FIG. 2.—THE LARYNGOGRAPH.

In order to study the motions of the thorax, abdomen, and larynx, and to render them visible to the pupil, so that the latter can correct such as are defective and see if he has made any progress, Mr. Piltan has devised a series of ingenious apparatus, which he has had Mr. Verdin construct for him. Those designed for the study of the motions of the thorax and diaphragm consist of a rubber ampulla, which is applied, through a belt or stays, to that part of the body that is to be studied. Rubber tubes (Fig. 3) connect these ampullas, which are hidden under the clothing, with drums hermetically closed, and provided with a membrane, upon which rests the extremity of a light style, mounted like a lever (Fig. 1), and the indications of which, thus amplified, can be easily read upon a dial, or registered automatically upon a revolving cylinder covered with lamp black. For motions of the larynx, the receiving apparatus is the same, but the transmitter is a little different, since here the motions are vertical. It consists (Fig. 2) of a small lever provided with a cushion at the extremity of its longer arm, and which rests upon the front of the neck. The other extremity rests upon the membrane of a drum connected with the receiver through a rubber tube. The apparatus is held in place by means of a cravat and of two rods which rest upon the clavicles. Upon examining the motions of the thorax and abdomen during respiration, it is found that those singers who possess a fine voice always and unconsciously respire in the same manner, while those who have defective voices have absolutely different respiratory types. If we seek the relation existing between the motions of respiration and those of the glottis, we find that the slightest depression of the diaphragm, after an inspiration, suffices to produce an occlusion of the glottis, the motions of which are always slight. From all these observations, Mr. Piltan draws the following conclusions :

The voice is the result of a shock and struggle between the muscles of inspiration and expiration. The point where this shock and struggle occurs determines the pitch of the sound. The larynx and glottis, instead of forming the sound, merely modify it. It is the respiratory motions, of which we are master, that characterize the human organ. In order to have a voice, were it only a question of being able to contract the vocal cords, consumptives, and the aged in whom they are healthy, might have fine voices, but what they lack is respiration.

If the glottis had motions peculiar to itself, being given the insignificant breathing necessary to produce the intensest sounds, it would suffice, in order to give voice to all subjects, to teach them to make a slight motion of the glottis. But this is not the case, and in order to have a voice it is necessary to know how to respire.

By means of the apparatus above described, the author of these interesting studies has been enabled to formulate a method, which he is teaching at the Rudy Institute.

Upon placing one apparatus at the thorax and another at the diaphragm (on a level with the navel), it is found that if, during the motion of inspiration and expiration, the two styles mark the same angle at the same instant upon the receiving dial, or, what amounts to the same thing, if they trace two parallel lines (Fig. 4, No. 1) upon paper having a uniform motion, there is no sound rendered. If the traces are nearly parallel, the sound is dull, cavernous, hoarse. If, on the contrary, they are oblique or in opposite directions (Fig. 4, No. 2), we have the voice of good singers. Consequently, in order to produce a voice, it is necessary that there shall be an effort in the respiratory motion, that is to say, that the motions of the thorax and abdomen shall occur in contrary directions.

The pitch of the sound emitted is proportional to the effort of the diaphragm, and the intensity of this sound is determined by the resistance that the diaphragm opposes to the rapid depression of the thorax. In order to obtain a sound sung *piano*, it is necessary to restrain this sinking motion.

The tremulous motion must be attributed to a muscular weakness coming either from the thorax or abdomen. The style then gives a sinuous line (Fig. 4, No. 3). A person can correct himself of this defect with a little exercise.

The motions of the larynx are voluntary. Depression is necessary in order to obtain amplitude, rotundity, and equality of sounds. It is low with *o*, a little less with *a*, and rises higher and higher with *e*, *u*, *i*, etc. The singer provided with the laryngograph (Figs. 2 and 3) can follow the motions of his larynx on the dial and correct them as need be.

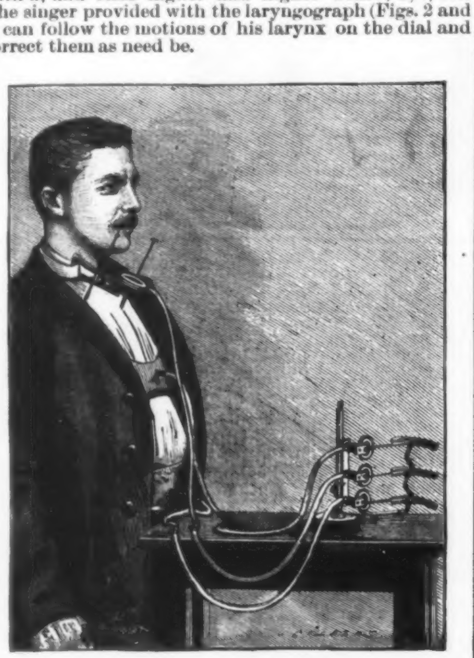


FIG. 3.—METHOD OF USING THE APPARATUS.

The apparatus as a whole, then, gives all the indications necessary, to the professor as well as to the pupil, for correcting the defective motions of the different organs that concur in the production of a fine voice.

In conclusion, we can do no better than quote, without comment, the very words of Mr. Saint Saens' report:

"Mr. Piltan's results are of the highest interest. It is the first time that a truly scientific method has been applied to the art of singing. . . . From these new facts, Mr. Piltan has deduced a rational system for teaching singing which he is applying with genuine success. . . . While leaving to him the entire responsibility for his conclusions and his methods of teaching, there is reason for encouraging his physiological studies and his instruments of investigation."—*La Nature.*

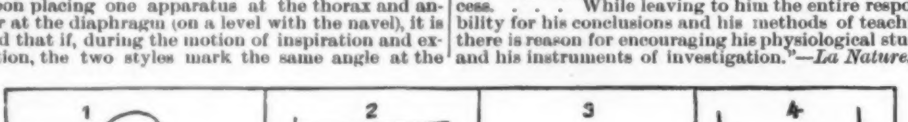


FIG. 4.—CURVES TAKEN AT THE THORAX (*t*) AND ABDOMEN (*a*).

THE UNKNOWN IN AMERICAN ORNITHOLOGY.

By E. M. HASBROUCK.

DURING the last ten years in which scientific investigation has been pushed forward, the scientists in the various departments have, as may be imagined, left no stone unturned whereby new discoveries might be made or achievements attained. In each and every branch marked advancement has been made; the antiquarian has unearthed new relics in Pompeii, the inventor has discovered new methods for the application of steam, new and marvelous discoveries have been made as to the various uses to which electricity may be put, while recent explorations in hitherto almost unknown lands have brought to light new species of mammals, birds, reptiles, and fishes.

Looking at all the departments of science, and the amount of research in each, it is safe to say that no branch has received more attention than that of ornithology. This may at first seem a bold assertion ; but when we remember that boys all over our land are making collections of birds' eggs, nests, and skins, taking to this pursuit rather than investigating steam, electricity, etc., because it takes them into the open air, through the woods, and along the streams, and that a goodly proportion form such an attachment for it as to remain investigators to a more or less extent throughout their lives, it does not appear so great an assertion after all. Three years ago the agricultural department took up the subject of migration, sending out schedules to hundreds of individuals, requesting that they be filled out and returned. Many who had hitherto paid but little attention to our birds now took a new interest, and from observing the migrations gradually came to take a deeper and keener relish in studying and knowing the *avi fauna* of the surrounding country, until now the land is covered from Canada to the Gulf of Mexico, and from ocean to ocean, with enthusiastic workers in this department.

Despite the earnest manner in which researches have been made, much of importance remains to be done; not only are there still wide fields for new discoveries in different parts of North America, but much relating to certain known species is still a special *desiderata*. It is surprising upon making an analysis of our *fauna* to find that with a number of well known, and in some cases even common, birds, to say nothing of the rarer ones, information relating to one or more points is needed to complete the biography of those species.

It seems strange that such a state of affairs should exist, especially when relating to well known species, when we think of the large army of workers constantly in the field ; and yet when we become somewhat acquainted with them, and learn what the desired information is, and certain circumstances connected with each, it sometimes seems as though at least part of it never would be discovered. Some facts will eventually come to light, but it will be more by good luck than good management. Some one, while exploring the wilder parts of Canada, will accidentally stumble upon the nest of the ruby-crowned kinglet (*Regulus calendula*), or while tramping through Mexico secure the female of the black-eared bush tit (*Baltriparus melanotis*). These but serve to show the kind of information needed, and when the accompanying schedule is consulted, it will be apparent how difficult a systematic search would be, as one might spend years in the proper localities, and hundreds of dollars, without success; while the very first outing the beginner took, he might run against these very things, and science be none the wiser.

To a certain extent I am a believer in what is termed "bull dog luck," and recall the time when as a boy I collected birds' eggs in company with my playfellows. We had in our collections several eggs which I would now give considerable to possess, and which no amount of systematic research has since placed before me. And now, in looking over the "haphazard" collections of the boys in passing through the country, we will find specimens of the rarer eggs mutilated and worthless to the owner, which, had they been forwarded to some scientist, would have been of value, and possibly have afforded important information. The point here is that some amateur collectors in the more remote localities, perhaps some school boy with a small collection, may have something of note to say upon some one of the species mentioned. If so, let us have it. Don't hold back for fear of making blunders! Others have made them, and only by repeated attempts and failures can we hope to at last achieve success.

So much for the amateur and luck. As stated before, no amount of research will disclose certain points, yet there are some facts desired that a thorough and systematic investigation could hardly fail to bring to light. This is true regarding some of the warblers, the three species of sandpipers, some of the sparrows and others; and the way would be for collectors in the localities frequented by these species to devote special time to them, and them alone, following up every clew until the desired information is obtained.

In this list of forty-four species will be found some that are well known, many extremely rare and little known, and still others that are hypothetical. By these last are meant those which have never been taken but once or twice, or whose validity as species is not firmly established; also those taken by Audubon and Wilson, and known only from their figures. Reference to the check list of the American Ornithologists' Union will explain these points more fully; to do so here would be but to copy that book, and would take up by far too much room.

With this work mapped out for us, and with the knowledge of where to go and what to look for, let us hope that at the close of another decade not only will new species have been added to our *fauna*, but that much that is desired concerning those already known will be brought to light and placed before the scientific world.

LIST OF BIRDS IN N. A. AVI FAUNA, WITH DESIDERATA CONCERNING EACH.

Alcidæ	Black-winged Guillemot (H)*	Establish validity of species, Habits, Nest and eggs.
	Kittletz's Murrelet	Birds, Habits, Nest and eggs.
	Sooty Guillemot (H)	Birds, Habits, Nest and eggs.
	Whiskered Auk	Birds, Habits, Nest and eggs.
Anatidæ	Blue Goose (H)	Establish individuality of species, Habits, Nest and eggs.
Ardeidæ	Peale's Egret (H)	Establish validity of species.
Falconidæ	Zone tailed Hawk	Work out in various plumages Habits, Nest and eggs.
	White-tailed Hawk	Discover young.
Fringillidæ	Brewster's Linnet (H)	Rediscover species, Establish validity of species, Habits, Nest and eggs.
	Evening Grosbeak	Nest and eggs.
	Harris' Sparrow	Habits, Nest and eggs.
	Le Conte's Sparrow	Nest and eggs.
	Rufous-crowned Sparrow	Nest and eggs.
	Townsend's Bunting (H)	Rediscover species, Establish validity of species, Habits, Nest and eggs.
Laridæ	Elegant Tern	Young, Nest and eggs.
Micropodidæ	Black Cloud Swift	Habits, Nest and eggs.
	White-throated Swift	Nest and eggs.
Mniotiltidæ	Bachman's Warbler	Habits, Nest and eggs.
	Blue Mountain Warbler (H)	Rediscover species, Habits, Nest and eggs.
	Brewster's Warbler (H)	Establish validity of species, Habits, Nest and eggs.
	Carbonated Warbler (H)	Rediscover species, Habits, Nest and eggs.
	Cincinnati Warbler (H)	Rediscover species, Establish validity of species, Habits, Nest and eggs.
	Connecticut Warbler	Habits, Nest and eggs.
	Grace's Warbler	Nest and eggs.
	Kirtland's Warbler	Habits, Nest and eggs.
	Lawrence's Warbler (H)	Establish validity of species, Habits, Nest and eggs.
	Olive Warbler	Work out in plumages, Habits, Nest and eggs.
	Small-headed Warbler (H)	Rediscover species, Habits, Nest and eggs.
	Swanison's Warbler	Work out in plumages, Habits, Nest and eggs.
Paridæ	Black eared Bush Tit	Discover female.
Phœnicopteridæ	American Flamingo	Breeding habits.
Picidæ	Williamson's Sapsucker	Nest and eggs.
Procellariidæ	Ashy Petrel	Habits, Nest and eggs.
	Black-capped Petrel	Discover young.
	Black Petrel	Habits, Nest and eggs.
	Hornby's Petrel (H)	Birds, Habits, Nest and eggs.
	Pink-footed Shearwater	Habits, Nest and eggs.
	Slender-billed Fulmar	Discover young.
Scolopacidæ	Cooper's Sandpiper (H)	Rediscover species, Establish validity of species, Habits, Nest and eggs.
	Least Sandpiper	Nest and eggs.
	Pectoral Sandpiper	Nest and eggs.
Sylviidæ	Ruby-crowned Kinglet	Plumage of young, Nest and eggs.
	Cuvier's Kinglet (H)	Rediscover species, Habits, Nest and eggs.
Tyrannidæ	Beardless Flycatcher	Nest and eggs.

GENERAL SUMMARY.

To be rediscovered	8	species.
Validity to be established	9	"
Nests and eggs to be found	38	"
Young to be discovered	4	"
Plumages to be worked out	3	"
Breeding habits alone	1	"
Specimens of known species desired	3	"
Females to be discovered	1	"

[Concluded from SUPPLEMENT, No. 630, page 10066.]

ASTRONOMICAL TELESCOPES AT THE MANCHESTER EXHIBITION.

BESIDES the twin equatorial which we have already described, Sir Howard Grubb exhibited an equatorial refractor of 5 in. aperture, the mounting of which was arranged so as to dispense with clamps. Fig. 1 annexed shows a perspective view of this instrument, while Fig. 2 is a section showing the arrangement of the polar and declination axes. From this latter view it will be seen that the polar axis proper (which is bolted to the casting traversed by the declination axis) is placed within a second tubular axis of brass which is made in one with the worm wheel on to which the clockwork drives. The brass circle graduated in right ascension is mounted on the central axis just above the driving wheel referred to, while at its lower end the main polar axis bears upon a set screw carried by the tubular axis as

FIG. 1.

shown, so that the contact between the edge of the right ascension circle and the driving wheel can be regulated. Altogether, the arrangement is such that while sufficient frictional connection is given between the main polar and the tubular axis to enable the clock to drive the telescope, yet the latter is left free enough to be shifted by hand when setting.

In the same way the declination axis—which is of wrought iron and made tubular for a reason we shall explain presently—traverses a brass tubular axis within the casting which is bolted to the polar axis, the declination axis having a conical bearing in the brass at the end next the telescope, and the tightness of frictional contact being adjusted by nuts at the other end as shown. The declination circle is at the end of the declination axis next the telescope, the vernier being carried by the latter.

Both the right ascension and declination circles are illuminated by an incandescent lamp, the lighting

Fig. 3.

being excellent, and both are read from the eye end of the telescope. In the sectional view the reading microscope is shown outside the telescope tube, but in the instrument exhibited at Manchester it was kept inside the tube, as shown in our perspective view. The declination circle is read by a single reflection from one prism, but in the case of the right ascension circle the reflection takes place from three prisms, namely, that in the reading microscope and two others at the end of the declination axis, the direction of the rays of light—which traverse the hollow declination axis—being indicated by the dotted lines in Fig. 2. The driving clock is arranged within the equatorial head, the weights descending inside the supporting column.

In connection with this instrument was shown a micrometer, of which we give a perspective view in Fig. 3 annexed; this micrometer with its incandescent

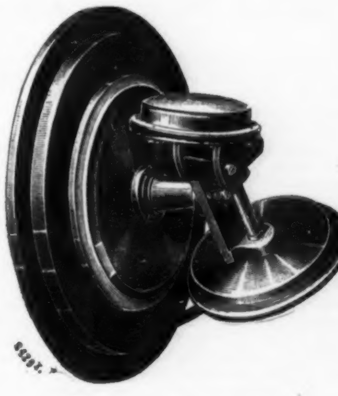


FIG. 4.—STAR FINDER.

light and battery for illumination being entirely self-contained.

Fig. 4, annexed, shows another of Sir Howard Grubb's exhibits, namely, a star finder intended for use with a telescope not equatorially mounted. This contrivance consists of a spherical spirit level mounted in one end of the short axis which is shown in an inclined

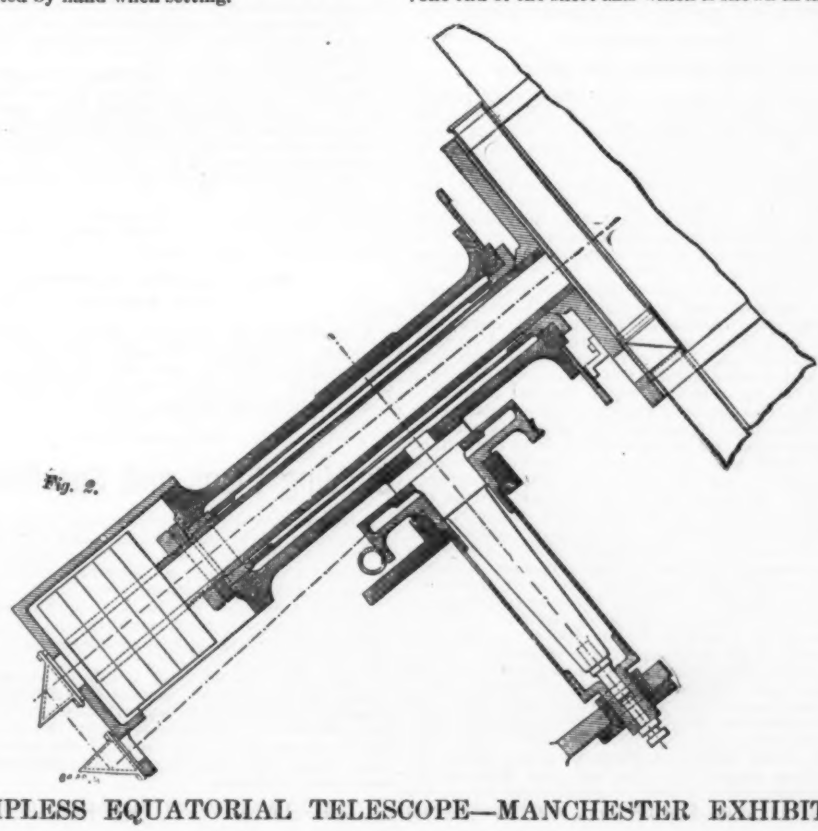


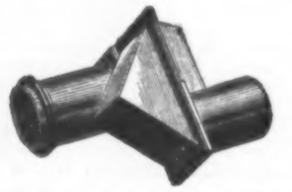
Fig. 2.

CLAMPLESS EQUATORIAL TELESCOPE—MANCHESTER EXHIBITION.

* (H) means that the species is in the "hypothetical" list of A. O. U. check list.

position in the engraving, the angle which the plane of the level forms with this spindle being adjustable to suit the latitude of the place when the telescope is used. The axis just mentioned carries at its other end a divided hour circle, and it turns in bearings formed in a casting fixed at the end of the stud or horizontal axis shown in our illustration, this stud also carrying a vernier which moves against a divided declination circle mounted on the flange by which the instrument is attached to the telescope. When the plane of the spirit level is at right angles to the plane of the attaching flange, the hour circle will read XII or XXIV, and if the telescope be moved until the bubble of the level occupies the center of the slightly spherical glass surface under which it moves, it will be brought into the meridian, and it can then evidently be set to any declination by the declination circle. To find any star, the right ascension and declination circles have only to be set to the proper readings, and the telescope then moved until the bubble of the level occupies the central position, when the telescope will be found directed to the point required. The instrument, if carefully used, gives far greater accuracy of directing power than might be at first thought possible, and it is a handy contrivance which will add greatly to the usefulness of a telescope not provided with an equatorial mounting.

Although not intended for astronomical purposes, we may notice in the present article a binocular telescope of new design which Sir Howard Grubb exhibited at Manchester. In binocular telescopes as hitherto constructed the aperture available has been limited by the fact that the distance between the center lines of the two tubes must not exceed the distance between the centers of the two eyes of the user. Sir Howard Grubb has, however, got rid of this limitation by the adoption of the form of eye piece of which we annex an engraving. In this eye piece the reversal necessary



EYE PIECE OF BINOCULAR TELESCOPE.

to get a direct image is effected by reflection by two prisms, the disposition of which brings the eye piece out of the line of the axis of the telescope. By varying the sizes of the prisms, any desired degree of eccentricity of the eye piece can thus be obtained, and in a binocular telescope the eye pieces can be kept at the proper distance to suit the eyes, while the telescope tubes are considerably further apart. The binocular telescope exhibited at Manchester was of 4 in. aperture, but of course still larger apertures could be employed.

Besides the telescopes already noticed, Sir Howard Grubb's exhibits at Manchester included examples of his 3 in. student's equatorial with circles divided on paper; a 4 in. telescope mounted on the siderostatic or lazy principle—in which the telescope tube is fixed and directed downward, the object viewed being reflected into it by a mirror having a clockwork movement; as well as an excellent collection of spectroscopes, eye pieces, object glasses in various stages of manufacture, etc. Models showing the great Vienna equatorial (already fully described in our pages) and the mounting designed by Sir Howard Grubb for the great telescope at the Lick Observatory, California, were also exhibited. In this latter arrangement, of which we shall have more to say at some future time, all the motions of the telescope and dome are electrically controlled, while a rising and falling floor is provided for carrying the observers. Altogether, the collection of exhibits at Sir Howard Grubb's stand was an exceedingly good and interesting one, and well showed the capabilities of the widely known Dublin manufactory.—*Engineering.*

THE LOW MOOR IRON WORKS.

THINKING that a description of these works might be of interest to the readers of *Fibre and Fabric*, I made some notes while being shown through them, a short time ago. We called at the office of the company to obtain permission and a guide who could explain everything to us. Here we were kindly received by the president, who, as usual, asked us our profession. When the preliminary questions were duly answered, we were requested to leave our autographs in the visitors' book, which was a real curiosity, having names in from all over the known world. Some of the names were in Chinese and Burmese, and were very peculiar. The latter were written from right to left, and looked like nothing but *u's* and *w's*. When the guide came along we asked him if he was going with us, and he said, "Hi am barn wi' ye." We were first shown where the iron ore and a small quantity of lime were put in a truck and run up an incline where the box tipped the contents into the furnace, when the strong blast soon reduced it to a liquid form, and the dross was continually running from this into a square hole in the ground to be afterward used in repairing the public roads. While the metal was being reduced in this way, men were at work making a mould on another part of the ground for the metal to run into, which made it into bars called "pig-iron bars." From here the bars are taken and formed into big square cakes. These are broken up and put into a puddling furnace under a tremendous blast. As soon as this was again thoroughly melted, a man put a long bar of iron through a small hole and formed a large ball of iron on the end, which was given to a man at the steam trip hammer, while another man, wearing a pair of boots of sheet iron, worked the ball around, at first with light taps of the hammer and increasing as the metal became more solid, at last forming a square piece of iron, about one foot square and six inches thick; this being sent to be used as required, some for the boiler plates, and some for rivets, being reduced down under steam hammers. We were then shown into the rod iron department. Here one man pulled a piece of red-hot iron out of the furnace, about 15 or 16 inches long and three inches thick. This was run through a pair of very heavy rollers, and cut with a series of grooves gradually becoming smaller, which soon brought this piece out in as many feet as there were inches before. This, while hot, was picked up by a boy who placed it under a punch, which cut it up into pieces two inches long. Another boy put it into a round plate which revolved under two punches, one pressing the piece down into the bottom of the die, when the other came down and formed the head and stamped the words "Low Moor." These were then automatically ejected into a box.

In the boiler department, the heavy rollers for making plates were run by a pair of engines of 50 inches diameter of cylinder, and geared direct to a shaft drawing the rollers. The engines were arranged with reversing gear, and were the best gotten up that I ever saw. The engineer amused our party considerably by showing them what control he had over them. He would run the engines at full speed and suddenly reverse the valve and run them at full speed backward, which was done without the slightest jar. Then at full speed he would stop them at any point we chose to name, but so suddenly that we were all surprised. To show us what advance engineering has made in the last few years, he showed us an engine made by Emmett, in the year 1791, which is still used by them for pumping water and working the blast. This engine is like those made at that time to use steam only on the under side of the piston, and it took steam the whole length of the stroke. The return was made by atmospheric pressure above, and a vacuum in place of the steam below. This engine was an object of great interest to our party, with its wooden walking beam 12 inches square and 10 to 12 feet long, having at the cylinder end another piece placed across it at right angles, so that if the crank end should give out at any time, it would strike on the piece and not go through the cylinder bottom. This beam has been used ever since 1791, without being replaced. The beam for swinging on had a piece of six inches round iron strapped on the square beam on the bottom side, and these in turn worked in boxes placed on the upper floor. The air pump condenser and all the valve motions were again worked by smaller beams or levers from the main walking beam. Not a cam pulley or tappet of any kind was used around it anywhere, all being accomplished by levers.

HARRY WARDMAN.

VERY OLD AGE.

THE death is reported from Constantinople of a man named Dimitrios Antippa, at the extraordinary age of one hundred and fifteen years. The deceased was born at Cephalonia in 1772, and, though in his later years he settled down as a merchant in the Turkish capital, he had passed his earlier days in Paris during the reign of terror, having had among his personal friends Marat, Danton, and Robespierre. To the last M. Antippa retained his clearness of intellect.

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